JAN 4 1924

Volume 30 JANUARY, 1924 Number 5

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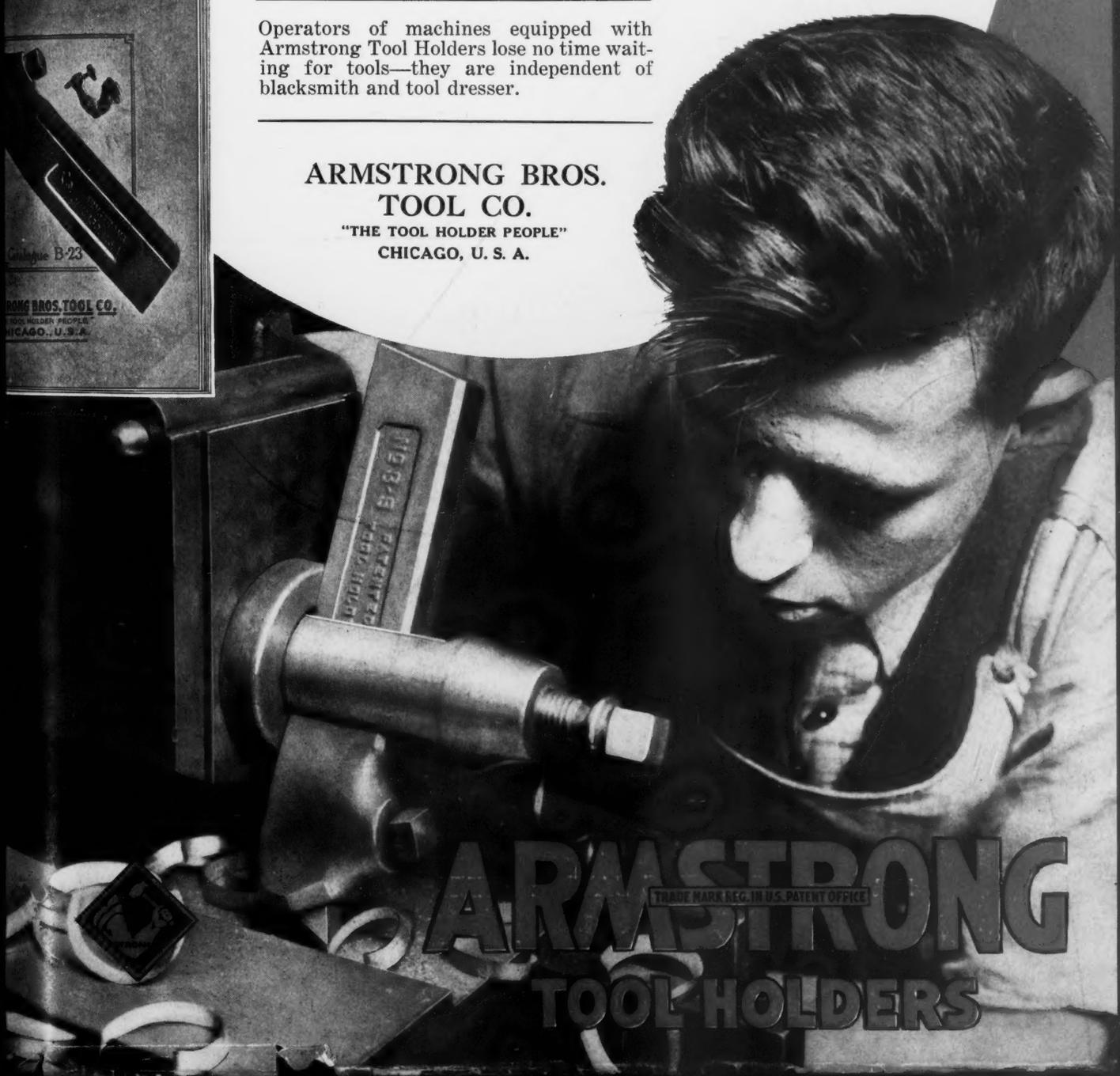

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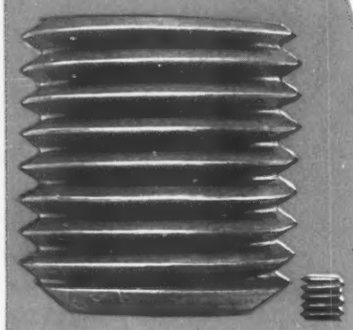

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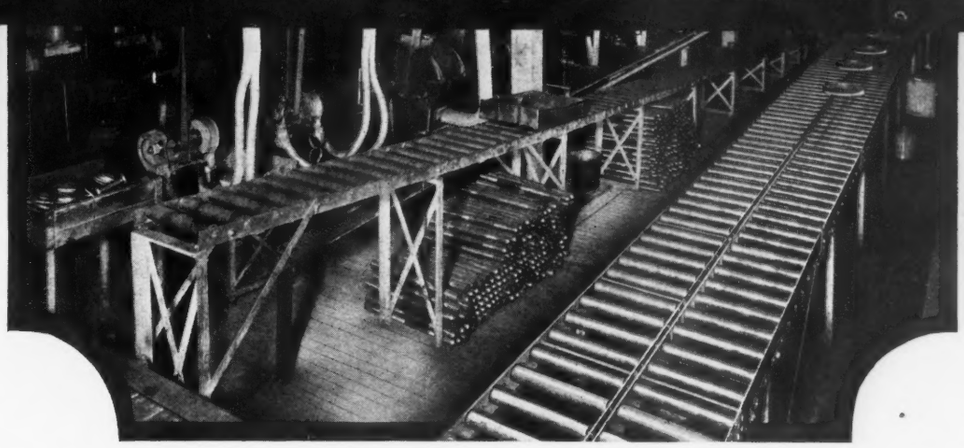
Gravity Conveyors in the Machine Shop



Advantages Derived from the Use of Gravity Conveyors in Medium-sized Machine Shops, and Points to be Considered in their Installation

By MATTHEW WILLIAM POTTS, Consulting Engineer, New York City

TODAY, more than ever, the executive realizes that common labor, which he considered the cheapest item of his costs, is by far the most expensive. This has been brought about by the present immigration laws, which have produced a shortage in unskilled labor, so that it is now necessary to utilize mechanical equipment that will make it possible to handle production with the least amount of man power. Because of present plant construction and machine installations, certain types of conveyor equipment often cannot be installed, either due to the difficulty of providing drives, or to limited space between production machine equipment. It has been found, however, that gravity conveyors, owing to their wide range of design and flexibility, can easily be applied in some form or other, to a number of machine-shop material-handling operations.

Large manufacturers of machine equipment are extensive users of some form of gravity conveyor, but the managements of smaller shops are generally under the impression that their problems are not big enough to require the installation of such material-handling equipment. This is erroneous, and is causing the loss of thousands of dollars annually to small shops, which are more in need of saving every dollar possible than are some of the large manufacturing plants. The small shop, if it is at all busy, requires every inch of floor space for equipment, and should strive in every way to cut costs in order to meet competition. If the executive will take time to investigate, he will find that a great percentage of the manufacturing costs in small shops is directly chargeable to labor expended for handling materials between machine operations, and also to idle machine time caused by the operators having to wait for the material to be delivered to the machines, or to go about searching for the material when it is required.

By organizing the shop in such a way as to insure immediate delivery of materials, the costs of manufacture can be reduced and production increased. An intelligent installation of the gravity conveyor will do much to bring about this organization. This is one of the cheapest types of conveyors to install. The absence of electrical or mechanical power devices reduces the first cost, and operating costs for conveyors of this type are at a minimum.

The standardization of the gravity conveyor in short sections makes it simple to install, and installations can be made with little interruption to production. For this reason, when it is necessary at any time to make plant changes, lines of gravity conveyors can be easily moved into new positions and made to serve other

The author of this article has had ten years' experience in the installation, design, and maintenance of material-handling equipment, and hence is well qualified to present information on the subject of gravity conveyor installations. In 1916 one of the largest individual installations of material-handling equipment in the chemical industry up to that time was laid out and designed by him for the Amo-Phos plant at Warner, N. J. He also designed the elevating and conveying equipment of the Air Nitrate plant at Muscle Shoals. His experience has covered the application of all types of material-handling equipment from the well-known screw conveyor to the most modern installations, including lift trucks, tractors and trailers, cranes, and special equipment. Mr. Potts specializes as a consulting engineer, making reports on and investigating the installation of material-handling equipment.

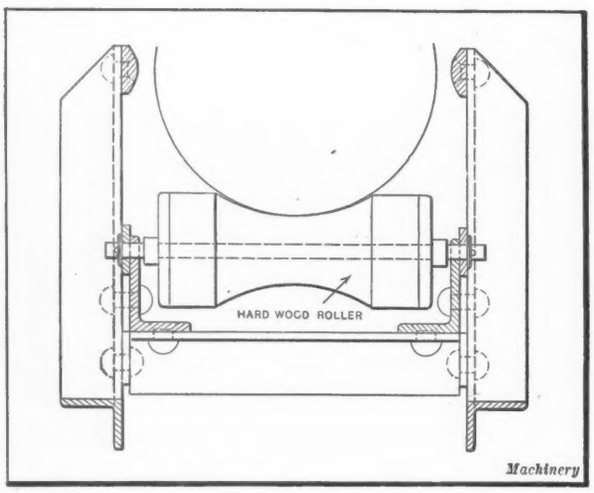


Fig. 1. Diagrammatic View of a Conveyor having Concave Rollers

purposes. The method of sectional make-up is particularly advantageous for work requiring portable conveyors, or where production methods require frequent changes.

Because of the simple compact construction of gravity conveyors, they occupy very small space, and can be installed overhead, at intermediate heights, or on the floor. The freedom from electrical or mechanical power also makes it possible to install them for outside work, but the most decided advantage of this type of equipment is its portability. Almost anything can be carried on the gravity conveyor, and parts having at least one flat surface are carried directly on the rollers. Small parts should be placed in tote boxes, while parts of irregular shape are frequently carried on simple trays or in containers. The wide range of application and design of the rollers makes this equipment applicable to almost every small shop. Continuous improvement in design and workmanship has made it possible to convey materials at surprisingly low grades and with correspondingly long horizontal runs.

The secret of successful operation and design of a gravity roller conveyor is to have it heavy enough for the work required, and provided with bearings that will insure that each roller will turn freely. Analyses of installations of this method of conveying show that the natural efficiency of such conveyors is often sacrificed through misapplication. In many installations, not even ordinary foresight has been used in applying the proper conveyor to the work to be done, yet nothing more than a reasonable amount of imagination and study of conditions is necessary. As an instance of misapplication it is not uncommon, where plant changes are frequent, to find lines of gravity conveyors, originally designed for handling light materials, now handling extremely heavy castings or irregular objects, which require entirely different roller-center distances, bearing designs, and grades. When the conveyors eventually break down after being used wrong, the system is condemned in its entirety, without giving thought to the misapplication and abuse to which it has been subjected. This is a case where the fact that the equipment is so simple and easy to move results in its being put to such extreme uses as to make it impossible to operate successfully.

Design of Bearings for Gravity Rollers

To make each roller turn freely, particular attention should be paid to the method of supporting it in the frame, and to the bearing construction. The earliest type of bearing for gravity conveyors equipped with wooden rollers consisted of a simple steel shaft driven into the roller, turning in a hole punched in the side frame. This design permitted the roller to wear against the side frames, and frequently the wear was so great that the roller moved to one

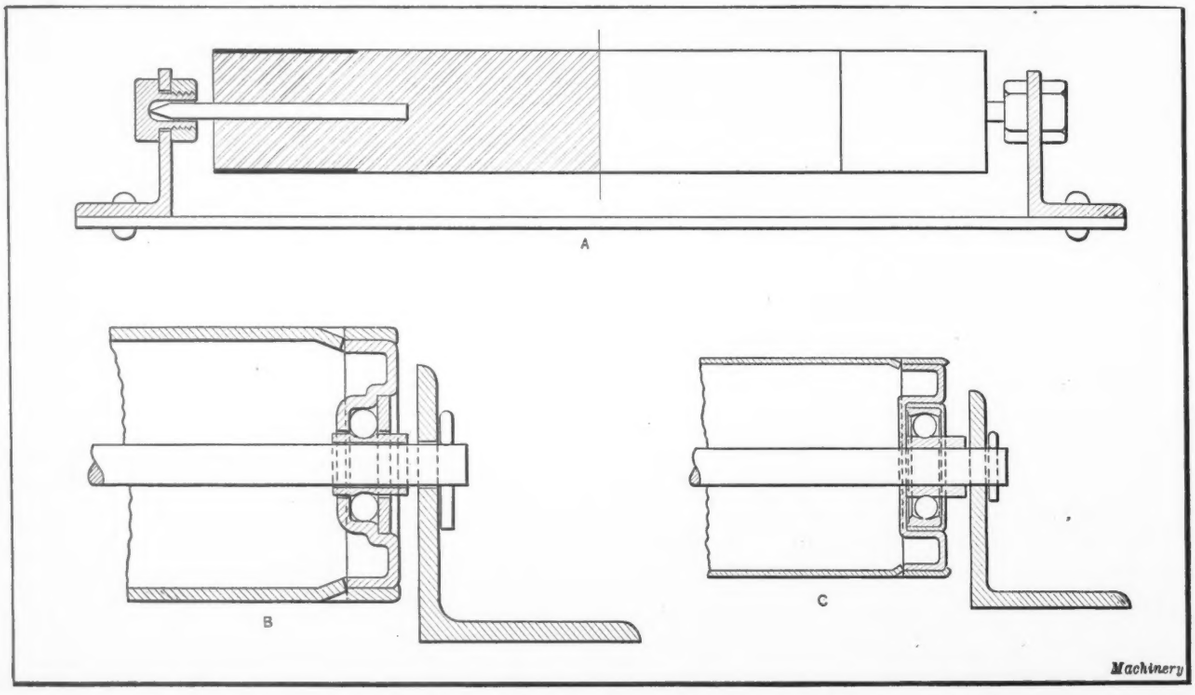


Fig. 2. (A) Roller in which a Casehardened Bushing is used as a Bearing; (B and C) Through-shaft Bearings equipped with Ball Bearings

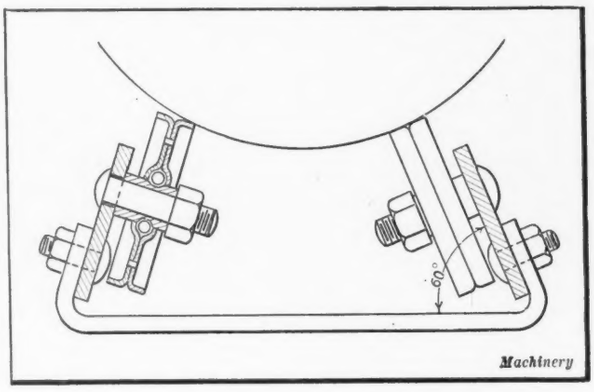


Fig. 3. Another Conveyor for Cylindrical Objects, which is furnished with Small Wheels instead of Rollers

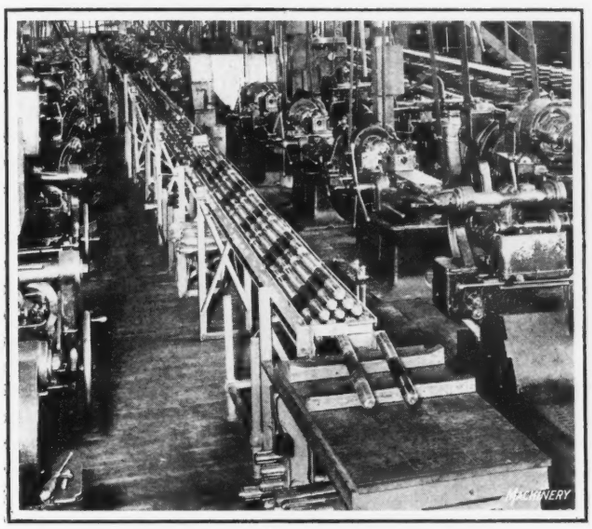


Fig. 4. Conveyor with Four Concave Rollers on Each Shaft, for conveying Several Parts at One Time

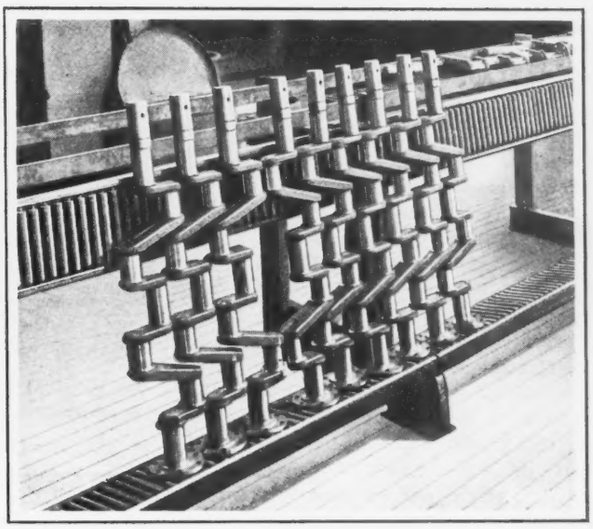


Fig. 5. Combination Conveyor employed for carrying Automobile Crankshafts

side sufficiently to permit the short shaft to drop out of the hole, thus making a "dead" roller. A modification of the first bearing consisted of a casehardened threaded bushing, in which the roller shaft turned. This design is shown at *A* in Fig. 2, and while it is an improvement over the first type, it is far from perfect. However, there are many conveyors used today for light duty in which this construction is employed. But the large amount of friction and wear attendant upon these two types of construction, has caused them to be generally discarded in favor of the anti-friction bearings at present almost universally applied.

Anti-friction bearings come under two classes, stud and through-shaft bearings. The ring-type stud bearing consists of a stud held by two nuts in position on the side angle-irons of the conveyor and equipped with a ring on which the conveyor roller rotates. There is also a ball-bearing type of stud bearing that is similar in design, except that a ball bearing is substituted for the ring. The ring-type stud bearing is an improvement over the plain shaft bearing but inferior to the ball-bearing type. With the latter friction is reduced to a minimum, and it makes a satisfactory construction, especially for light-duty work. The stud construction has advantages and disadvantages; one of the main advantages is that it reduces cramping of the bearing due to possible springing of the side frame, and keeps down the gross weight of the conveyor, which is an important consideration if it is to be portable. Stud bearings can be used with wood, steel, or cast-iron rollers, and in all cases, the ends of the rollers are completely closed. This is an essential factor if liquids of any kind are likely to come in contact with the conveyor.

Through-shaft bearings equipped with ball bearings, as shown at *B* and *C*, give a more satisfactory conveyor for handling castings and heavy materials, particularly when the conveyor consists of long and closely spaced rollers, because the construction is somewhat heavier than the stud types. This bearing is especially adapted to permanent installations. One of its disadvantages is that the conveyor must have sufficient clearance on one side for the removal of the shaft endwise to allow the roller to be taken out of the frame. This requirement, however, is easily met in the majority of installations. It is recommended that the bearings be fitted in such a way that they may be easily removed from the roller for cleaning or replacing. The shaft or stud should be of first quality steel, preferably cold-rolled. Shafts are usually from $\frac{3}{8}$ to $\frac{7}{8}$ inch in diameter for ball bearings,

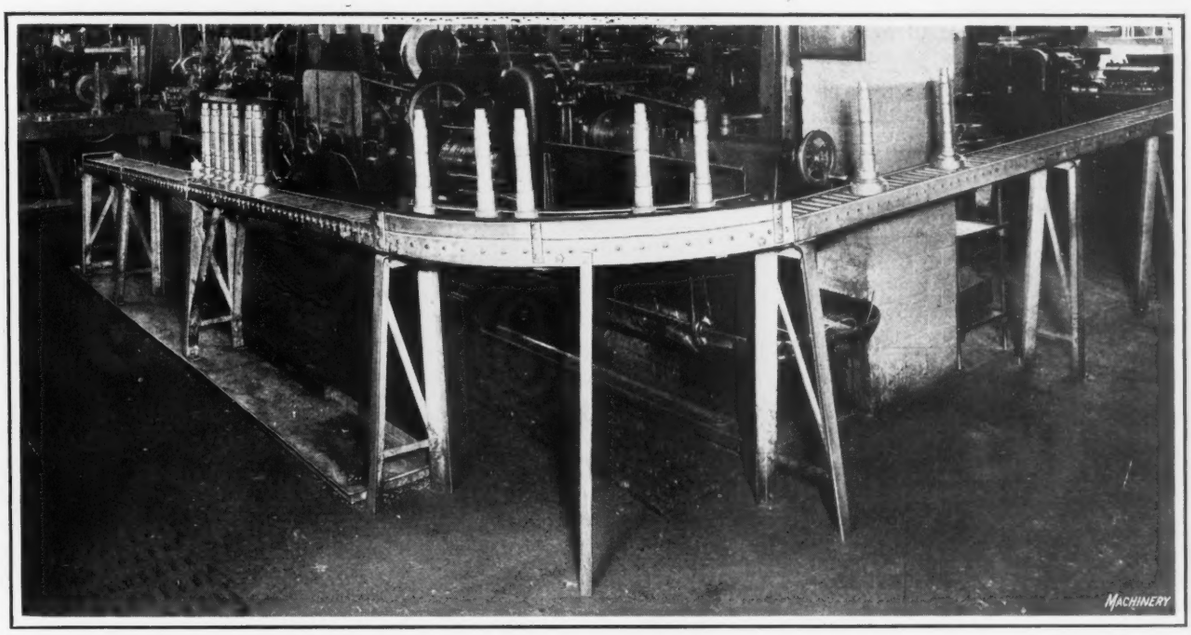


Fig. 6. Handling Top-heavy Propeller Shafts with Guards at the Curve only

and from ¾ to 1½ inches for roller bearings.

Accurately made bearings are necessary in order that the roller may turn easily about its true axis. Improper bearings increase the frictional resistance, and this has a direct influence on the pitch of the conveyor necessary to handle a given commodity. Keeping the bearings well greased is the first preventive of dead rollers and inefficient conveyors. The bearing might be considered as the most important part of the gravity roller system, but good bearings can be easily thrown out of alignment if the steel frame is not of a rigid or heavy construction. The frame should be so built as to eliminate any possible deflection under full load, and the sections should be securely cross-braced under the conveyor and between the rollers, to form a rigid unit. It is important that the holes for the shafts be punched accurately, so that the rollers will be parallel to each other and at right angles to the frame, and so that their tops will form one plane throughout the length of the section.

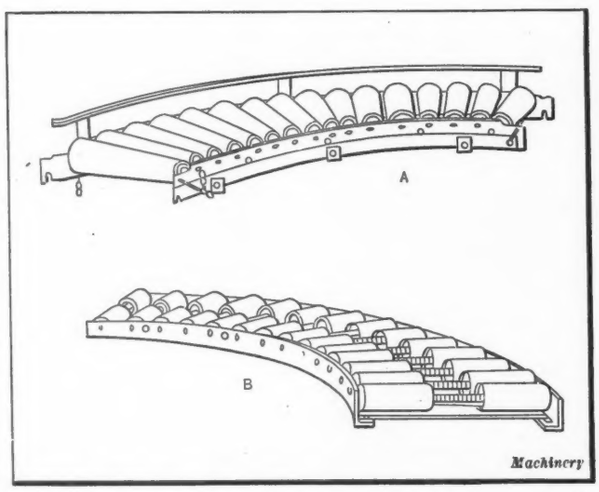


Fig. 7. Two Curves made up of Taper and Double or Differential Rollers, respectively

In general, 8- or 10-foot conveyor sections are most satisfactory, although the length may be varied to suit conditions. Each section should be fitted with end connections which lock, one to another, so that there will be smooth transition from one section to the other. In a portable conveyor, flexibility of use requires that these end connections be as quickly detachable as is consistent with accurate alignment.

Types of Rollers

Rollers should be fitted to the service required. Standard rollers range from 2 to 3 inches in diameter, and are made of steel tubing, hard wood, cast iron, or other serviceable material. They may be cylindrical, concave, or tapered, depending upon the material to be handled, and the place where they are located in the line of gravity. Straight cylindrical rollers, as shown in Fig. 2, are best for standard flat-faced parts, while concave rollers, such as shown in Fig. 1, are well suited to round objects, and generally do not require guard rails. If a definite size of round object is to be handled, a conveyor built up of roller wheels, as shown in Fig. 3, will also be found efficient. For handling a number of pieces at one time, a conveyor built up of four or five concave rollers mounted on a single through shaft, as shown in Fig. 4, will permit greater capacities to be handled, and will reduce the cost of supports and side frames.

Frequently if special or irregular parts are to be handled, a combination of standard gravity conveyors will be found most suitable. Such an installation applied to the handling of crankshafts, is shown in Fig. 5. Here the load rests on the lower rollers, and by having the shafts at a slight slant, they are guided by the upper rollers.

The useful life of the gravity conveyor can be prolonged by care in loading. The practice of throwing heavy parts on the rollers is to be condemned, but when careless loading is unavoidable, heavy sections with roller bearings should be provided at the loading points. Wooden rollers are not usually recommended for heavy duty, or continuous use, however, in many cases, their light weight in portable duty offsets their shorter life. The strength of wooden rollers may be somewhat increased by driving a metal ferrule on the ends, as shown at *A* in Fig. 2. For steel rollers, Nos. 14 and 16 gage steel tubing, preferably seamless, is satisfactory for ordinary service, while for heavy duty, No. 12 or No. 10 gage is recommended, or even No. 5 gage for very heavy work.

The width of the conveyor is a point that should be given careful consideration. As an average rule, it might be safely said that the over-all length of the rollers should be from 2 to 4 inches more than the width of the largest part to be handled. It is satisfactory, however, for steel parts, sheet metal, tote boxes, etc., to overhang the rollers, if the run is not too long. In portable work, there is a decided advantage in using the narrowest roller consistent with the nature of the work to be handled, because of the lighter weight of the section. Different diameters of rollers can be used, but the standard sizes previously mentioned are preferable.

It will be noted from the illustrations that the rollers are, in some cases, spaced close together, and in others, far apart. For instance, in Fig. 5 the rollers are closely spaced, with only a little clearance between them, while the heading

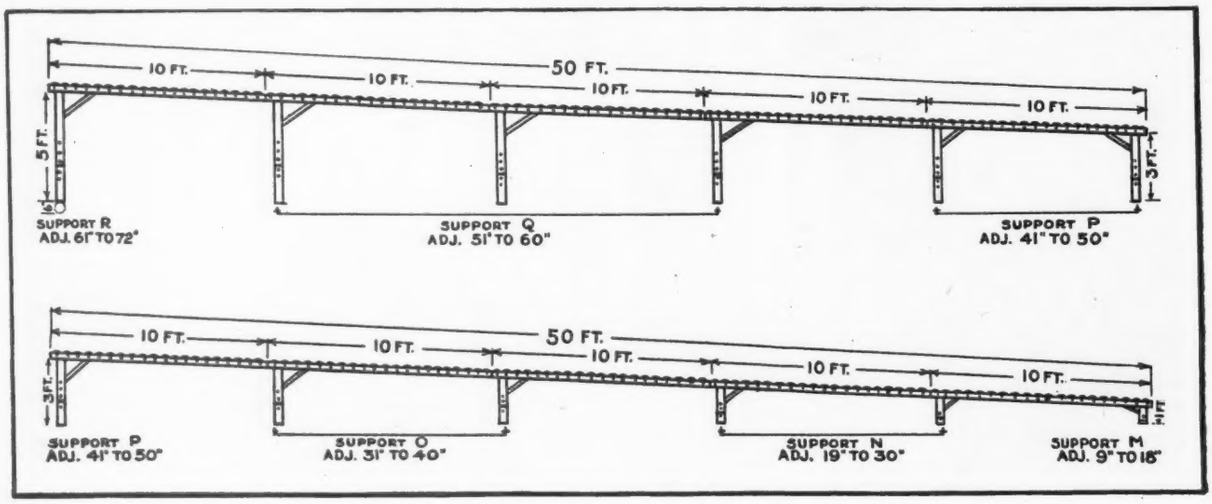


Fig. 8. Conveyor Frame Design that is Suitable for Indoor Installations

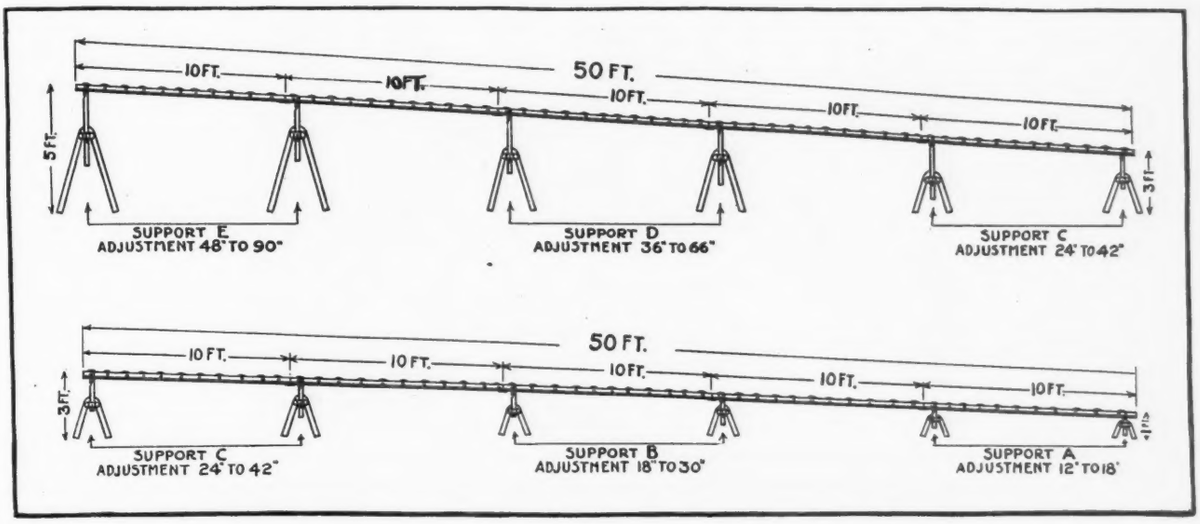


Fig. 9. Conveyor equipped with Two-leg Supports as recommended for Outdoor Installations

illustration shows rollers spaced with as much as 3 or 4 inches between them, and in Fig. 10 there is only about ½ inch. The spacing varies according to the kind of parts being handled. Certain companies have a standard spacing of rollers, but the average rule is to make sure that the commodities being handled rest on at least three rollers at all times. If the surface resting on the roller is rough, the spacing should be closer, but if long and smooth, such as in the case of tote boxes, the spacing can be further apart. For unusually large and heavy castings, as shown in Fig. 12, the general practice is to use large rollers, spaced close together.

Guards and Curves—Switches and Supports

Guard rails used to be provided on all gravity conveyors, but it has been found that there is usually little danger of parts running off the side of a properly constructed conveyor. However, with certain parts, and particularly in overhead installations and on curves, steel or wood-faced guards are recommended. In the ordinary application of this equipment in machine shops, it might be said that guards can be entirely eliminated. If, however, guards are felt to be essential, they should be low, so as to make it easy to place parts on and remove them from the conveyor. Fig. 6 shows a top-heavy highly finished piece being handled. It will be seen that guards are provided only at the curve in this installation. It might be taken as a rule that curve guards are the only ones necessary, particularly if the conveyor is supported from the floor, but for a matter of safety, if conveyors are supported from the ceiling, continuous guards should be provided.

Curved sections are used to carry parts around corners, and these curved sections are made to change the direction of travel at an angle of 22½, 45, or 90 degrees. The radius of the outside of the curve may be made to suit the specific requirements of the lay-out, and ranges from 2 feet 6 inches to 4 feet 6 inches. Curves fitted with straight rollers are satisfactory for many purposes, particularly where comparatively heavy work is handled. Such a curve is shown in Fig. 6, and it has been found successful in this installation. Some manufacturers, however, prefer taper rollers for the curves, as shown at *A* in Fig. 7. The amount of taper depends, of course, on the radius of the curve, being greater for a short radius than for a long one. Other manufacturers recommend the double or differential roller curve, shown at *B*, the outer roller of which rotates faster than the inner ones. The space between the differential rollers should be given careful consideration, particularly when small objects are to be handled. So many straight-roller curves have been successfully installed that the exact value of tapered roller curves and differential roller curves is somewhat questionable.

When two or more lines of gravity conveyors are required to deliver to one main trunk line, a curved inter-section is used, provided the operation is to be continuous. Frequently this form of inter-section is necessary because there are no operators to shift the parts to the main line of the conveyor, but such a switch is not recommended if it can be avoided, because of the possibility of jamming if two parts come together at the inter-section, that is, if one proceeding down the main line bumps into one being fed off the side line. This same section can be used as a diverter to feed from the main line to production machinery, but a better type of diverter is illustrated in

Fig. 10. Narrow Conveyor for handling Propeller Shafts between Machine Operations

Fig. 12, where there is another conveyor at right angles to the main line. In this case it is necessary for the machine operator to draw the material from the main conveyor to the feeder section. A two- or three-way switch in which a section of the conveyor can be shifted into alignment with two or three conveyor lines, making it impossible for material to jam at the intersection point, can also be obtained. While this type is somewhat more expensive than the other two mentioned, it is frequently cheaper in the long run, because of its more efficient operation.

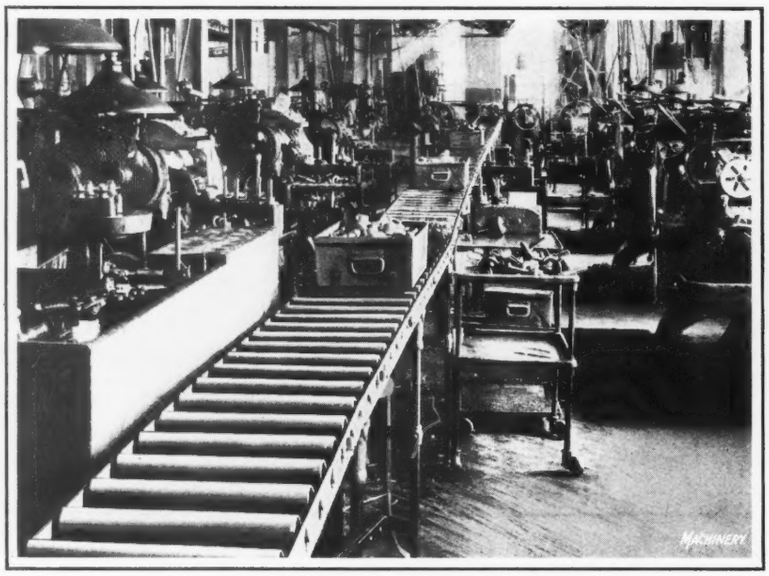


Fig. 11. Tote-box Conveyor installed in Congested Section of Shop

Although all the illustrations show gravity conveyors supported from the floor, there are many installations where they are hung from the ceiling or secured to wall brackets. It will be noted that there are many types of floor supports, differing in construction, and ranging from castings to angle-iron and pipe sections. Figs. 8 and 9 show two types of supports, that in Fig. 8 being recommended for indoor purposes, and that in Fig. 9 for outside purposes, the two-leg standard giving better support on rough ground. With either fixed or portable conveyors, the supports should have as much adjustment as is consistent with rigidity and strength. Usually one support for each 8 or 10 feet is sufficient, but where the parts to be handled are so heavy as to cause deflection, two supports should be used to a section.

The Conveyor Grade

It is difficult to give a rule for the proper grade at which gravity conveyors should be operated, as they vary so greatly with regard to the work being handled and the type of bearings used. Even approximate figures are difficult to give, and the best way to determine grades is by actual practice. Therefore, again, stress must be put upon the point that all support stands should be adjustable. In machine shops where the work to be handled is generally heavy machine parts, it is not unusual to find gravity conveyors operating on as slight a grade as 2 per cent. particularly where free-running ball-bearing rollers are used.

It will be noted from Fig. 10 that a steeper grade is required for handling individual pieces than for heavy tote boxes, filled with small castings, as in Fig. 11, while in the case of heavy castings such as shown in Fig. 12, a very slight grade is sufficient to keep the material moving on the conveyor. An example of the different grades that may be used is shown in the heading illustration, where three different types of conveyors of three different grades are employed to handle three different classes of materials.

It is in congested shops that gravity conveyors find their greatest application and efficiency, because the congested condition makes trucking an impossibility. Fig. 10 shows an installation where the machines are spaced far enough apart to permit some form of trucking if desired, but undoubtedly the gravity conveyor was installed because of its greater efficiency. Fig. 11 shows a congested shop, where it would be impossible for a truck of any type to be used without disturbing the machine operators. The gravity conveyor, however, carries materials through this bay of the shop without interrupting any machine operations. In the case shown in the heading illustration, where three different classes of materials are being handled in three different directions, it would be impossible in such a narrow space, for trucks to operate without getting in each others' way. The gravity conveyors, however, keep the materials moving in the right direction, and because of their continuous operation, there is no congestion or holding up of materials.

Where Gravity Conveyors should be Installed

Many executives are in doubt as to where gravity conveyors should be installed, and the following points are

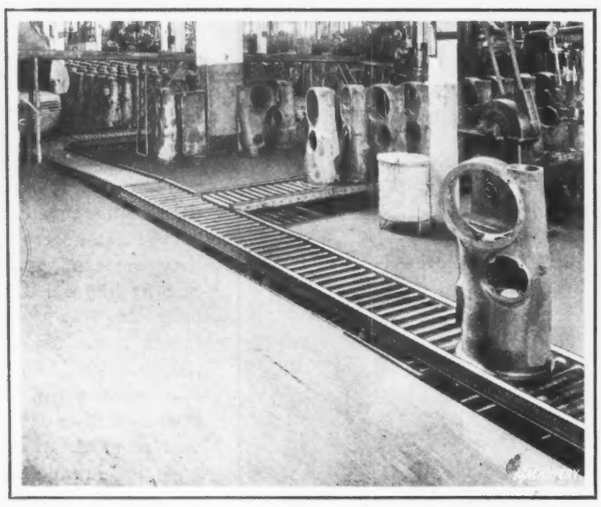


Fig. 12. Heavy-duty Installation located close to the Floor to do away with the Necessity of lifting the Heavy Castings

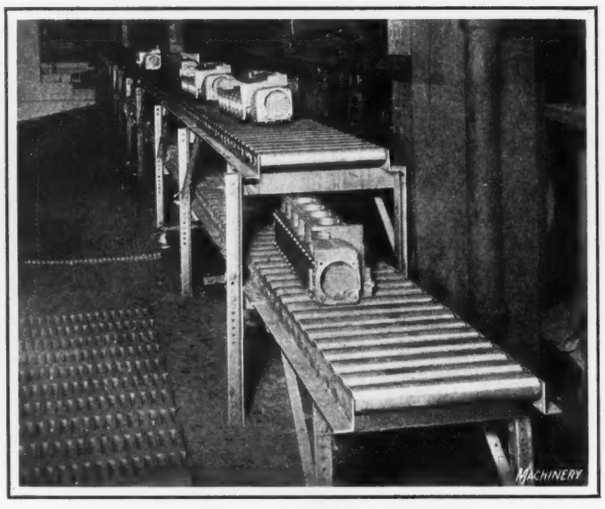


Fig. 13. Two Conveyors mounted on the Same Supports, by Means of which Work can be carried in Two Directions

therefore presented as guides to show the places where economies can be effected by installing this class of equipment:

1. Wherever a man has to stand in one place steadily, moving materials for over thirty minutes at a time.
2. Wherever a man has to move materials continually sidewise more than six feet, that is, two steps.
3. Wherever continuous assembly work is being carried on.
4. Wherever a fairly continuous stream of materials has to pass from one operation to another.
5. Wherever material has to be transported in a fairly continuous stream for more than 50 feet.
6. Wherever there is congested floor space.
7. Wherever trucking conditions are so bad that machinery is held up waiting for materials.
8. Wherever quantity production is required.

If it is decided to install gravity conveyors, careful attention should be paid to the lay-out and to the class of conveyor to be purchased, so that the rollers, bearings, and other parts best adapted to the work are installed. The executive should also ascertain, by investigation, just what economies can be effected by installing these conveyors. It might be an economy in space, in handling time, in production machine time, or in wages.

In order that the conveyor may prove its suitability, it must be kept fairly busy, show a profit in operation, and be so constructed that it can be shifted easily from point to point, as production requirements change, so that it can be kept busy on many operations. It will then show an appreciable profit, which will undoubtedly take care of its first or installation costs in a reasonable time, say after six months or a year.

The foregoing considerations apply mainly, of course, to the installation of new equipment in old plants, or in places where the nature of the work is subject to change. In the case of a new plant, it is frequently a good investment to install gravity conveyor equipment purely from the point of production and future expansion. For such installations the following principles should be considered:

1. Manual handling should be minimized; the handling of work should be considered as an actual step in the manufacturing process, and should be performed by machinery wherever possible.
2. Best results are obtained where the flow of materials through the plant is as uniform as possible, from the raw materials to the finished product.

In designing new plants or additions to plants, the various steps in the manufacturing process should be studied in detail. The machinery and equipment for the performance of the operations should first be decided upon, and the manufacturing units selected and balanced with reference to each other to prevent choke points in production. Then the method of handling materials and the structure should be determined.

Altogether too frequently new plants are designed with reference to light, structure, and the placing of machines, without giving any thought to the method of getting raw materials from the point of entry to the machines, carrying the materials through the various operations, and finally placing the finished product in stock or in cars for shipment. When the plant is being built is the best time to plan how materials should be handled, and the methods to be employed should be incorporated as a part of the general lay-out. With everything definitely decided before construction is started, considerable money can be saved and the proper equipment installed. In small shops in actual operation, it will be found that the installation of gravity conveyors is simple, and can be done with only slight changes in construction or arrangement.

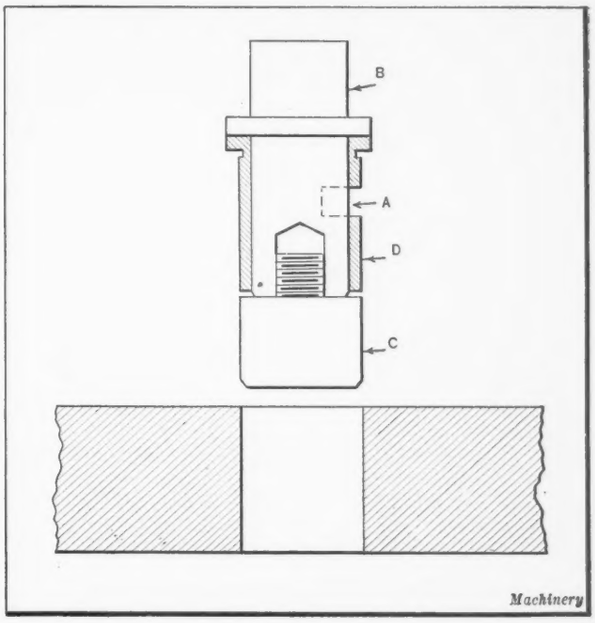
As previously mentioned, practically all gravity conveyors are built to stand hard usage, but the very simplicity of their construction creates a tendency to handle this equipment with less than ordinary care. Where conveyors are used infrequently, or for intermittent service, they are often left wet and dirty, whereas a little time spent in cleaning and oiling them would keep the equipment in far better condition, and would save time in getting them into condition on the next occasion when they are called upon to operate. The economy of operation of gravity conveyors in any plant is invariably increased by having some one man thoroughly trained in the proper assembling, handling, and care of sections, supports, bearings, etc., but even more important is the thorough training of employes in the possibilities of gravity conveyors.

* * *

BUSHING DRIVER

By FRANK SHIMPFLE

The device here illustrated is employed for driving the bearing bushings into the housings of an electric motor. As the bearings are of the oil-ring type, it is necessary to cut a slot or groove *A* in the bushing to permit the oil-ring to come in contact with the shaft. This weakens the bushing so that it is often bent or sprung at the oil slot to such an extent that a shearing cut is taken on its outer surface.



Device used for aligning and driving Bearing Bushing

The device designed to eliminate this trouble consists of a driving mandrel *B* and a pilot *C*, which are assembled on the bushing as shown. The driving member has a collar at the upper end which is accurately machined to make a good contact with the end of the bushing *D*. The section of the mandrel *B* on which the bushing is placed is ground about 0.002 or 0.003 inch smaller than the inside diameter of the bushing, for the reason that a thin shell bushing generally shrinks 0.001 or 0.002 inch when pressed into its seat. The pilot *C* is also ground 0.002 inch smaller than the hole into which the bushing is to be driven. Only five or six threads are required on the end of the pilot that screws into the lower end of mandrel *B*. After a bushing has been pressed into place, the pilot *C* is unscrewed and the mandrel *B* withdrawn.

* * *

At present there are 108 different types of passenger automobiles built in Great Britain. In addition there are 77 foreign makes on the British market. Of these, 38 are of French origin, and 19 are made in the United States. However, the total number of American cars sold in England is 75 per cent of the British imports in this field, as compared with only 20 per cent from France.

Design of Helical and Worm Gears

By M. K. AKERS

THE calculations necessary to determine the dimensions of helical and worm gears are rather laborious, and short cuts are desirable. Particularly is this true for the preliminary calculations, where it is necessary to determine the dimensions that will best suit a proposed machine. The accompanying chart is intended to supply these dimensional data to the designer in order that he may quickly and easily select the gearing that will best fit his needs. When the gearing has been selected, it is a comparatively small matter to make the calculations necessary to obtain accurate figures for the dimensions. Figures obtained from the chart are comparable in accuracy to those obtained with a 10-inch slide-rule.

The complete geometrical solution for a set of worm gearing or a pair of helical gears with shafts at right angles may be obtained from the following formulas:

$$\frac{d_2}{d_1} = \frac{r_1}{r_2} \tan a \qquad (1)$$

$$d_1 = \frac{2C}{\frac{r_1}{r_2} \tan a + 1} \qquad (2)$$

where d_1 = diameter of driving gear, in inches;
d_2 = diameter of driven gear, in inches;
r_1 = number of revolutions per minute of driving gear;
r_2 = number of revolutions per minute of driven gear;
C = center-to-center distance of gears, in inches; and
a = helix angle of driver, in degrees.

(Angle a is that angle which the direction of a driving-gear tooth makes with a line at right angles to the axis of the gear.)

The usual approach to the solution of a problem of this sort is to choose a helix angle based on the desired gear ratio and the service to which the gears are to be put. Since the amount of movement of the faces in contact increases as angle a is made smaller, a small helix angle means more rapid wear of the gears and a lower efficiency than if the angle is large. Therefore, if possible, an angle of 30 degrees should be used, and an angle of 45 degrees is desirable. Where large ratios are desired, and it is necessary to keep the gears small, a smaller angle must be used. If only a small part of the total power used is to be transmitted through the gears, as is frequently the case, efficiency is of little moment, and any angle that gives the necessary gearing will serve.

Having assumed a helix angle, a center distance is next assumed, and these values, together with the desired gear ratio, are substituted in Formula (2) which gives the diameter of the driver. This value subtracted from the assumed center distance gives the diameter of the driven gear.

This solution is complete in a geometrical sense, and if it were complete in a manufacturing sense there would be little excuse for a chart to assist in the problem. However, when the next step is taken—that is, when the number of teeth in the gear is found—in all probability the dimensions obtained will be such that there is no commercial cutter for the teeth, and if a standard cutter were used, a fractional tooth would result. It is necessary, therefore, to change the dimensions so that when standard cutters are used, whole teeth will result.

In a helical gear the number of teeth must equal

$$N = d \ (\sin a) p \qquad (3)$$

in which

N = number of teeth in gear;
d = diameter of gear; and
p = diametral pitch.

Formula (3) may be used for finding the approximate number of teeth in the gear, the result being changed to the nearest whole number and either angle a or diameter d adjusted to correspond. After similar changes are made on the mating gear, the solution is complete.

As an example, assume that there is desired a gear reduction of 13 to 1, with a high efficiency, and a center distance of approximately 5.75 inches. Assume also, that owing to the shaft size, the diameter of the driver should be not less than 0.6 inch. Giving d_1 a value of 0.6 inch and substituting in Formula (1), after two or three trials a value can be chosen for the angle that will give satisfactory dimensions. In this particular case assume an angle of 32 degrees; then

$$\frac{d_2}{0.6} = 13 \times 0.625$$

$$d_2 = 4.875 \text{ inches}$$

$d_1 + d_2 = 0.6 + 4.875 = 5.475$ inches = center distance C

This seems to be satisfactory, and so the step is taken to see if these figures, with the pitch selected, will result in whole teeth. In the following, N_1 = number of teeth in driving gear and N_2 = number of teeth in driven gear. Assume a diametral pitch of 12; then from Formula (3),

$$N_1 = 0.6 \times 0.53 \times 12 = 3.816$$

Thus, a fractional number of teeth results, and since this is impossible, the nearest whole number (4) is chosen, and a value d_1 to satisfy the equation must be found. This necessitates a value d_1 of 0.629 inch. For a gear ratio of 13 to 1, and with 4 teeth in the driver, the driven gear must have $4 \times 13 = 52$ teeth. From Formula (3) we obtain the following formula for the driven gear:

$$N_2 = d_2 \ (\cos a) p$$

Substituting in this formula the value obtained for the number of teeth, we have:

$$52 = d_2 \times 0.848 \times 12$$

$$d_2 = 5.111 \text{ inches}$$

and

$$C = d_1 + d_2 = 5.740 \text{ inches}$$

In the approach to such a problem by means of the chart, it is convenient to use a straightedge and start from the intersection of the line designating the diameter of the driver with that designating the number of teeth in the driver, and work backward. Thus the dimensions for a whole series of gears that will meet the conditions imposed may be quickly read off, and the designer is in a position to make a much wiser selection than if each pair must be calculated. For example, if he fixes the diameter of the driver, he can at once read off the helix angle for a given number of teeth for any of the common pitches. He can also fix the helix angle and read off the diameters for various pitches and different numbers of teeth. Then by continuing through the chart he can quickly determine the corresponding diameter of the driven gear.

Thus, starting in the lower left-hand corner of the chart at the line denoting the helix angle of the driver, proceed upward to the line denoting the pitch that has been selected. From this intersection, proceed to the right and read the

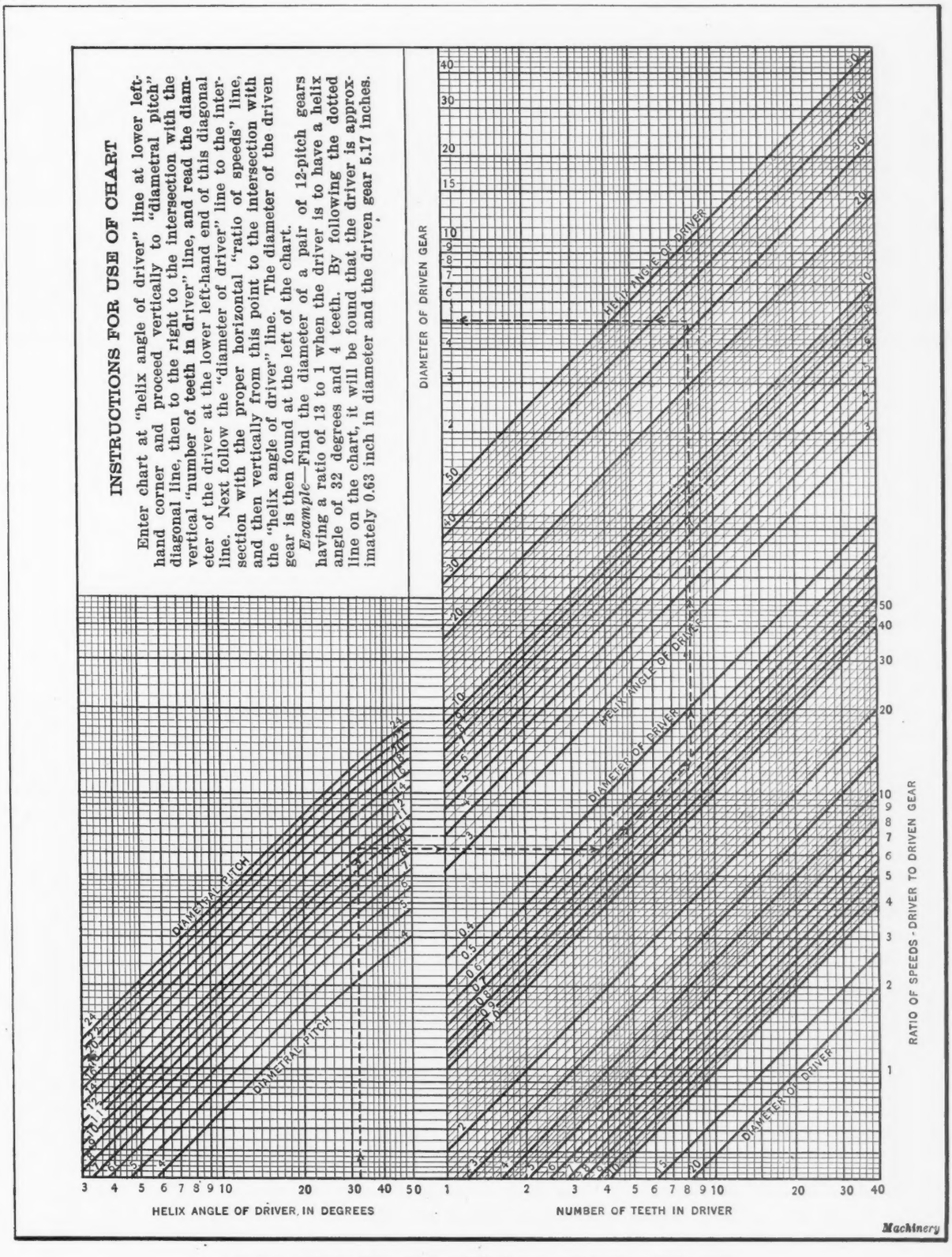

INSTRUCTIONS FOR USE OF CHART
Enter chart at "helix angle of driver" line at lower left-hand corner and proceed vertically to "diametral pitch" diagonal line, then to the right to the intersection with the vertical "number of teeth in driver" line, and read the diameter of the driver at the lower left-hand end of this diagonal line. Next follow the "diameter of driver" line to the intersection with the proper horizontal "ratio of speeds" line, and then vertically from this point to the intersection with the "helix angle of driver" line. The diameter of the driven gear is then found at the left of the chart.
Example—Find the diameter of a pair of 12-pitch gears having a ratio of 13 to 1 when the driver is to have a helix angle of 32 degrees and 4 teeth. By following the dotted line on the chart, it will be found that the driver is approximately 0.63 inch in diameter and the driven gear 5.17 inches.
DIAMETER OF DRIVEN GEAR
HELIX ANGLE OF DRIVER
DIAMETER OF DRIVER
DIAMETRAL PITCH
RATIO OF SPEEDS - DRIVER TO DRIVEN GEAR
HELIX ANGLE OF DRIVER, IN DEGREES
NUMBER OF TEETH IN DRIVER
Machinery

Chart for designing Worm Gears or Helical Gears with Shafts at Right Angles

diameter of the driver on the diagonal line nearest the intersection of the line being traced and the vertical line representing the number of teeth in the driver. Now follow the "diameter of driver" line up diagonally until it intersects the horizontal line corresponding to the speed ratio desired. From this intersection proceed vertically upward until the diagonal line representing the chosen helix angle is reached. The diameter of the driven gear is then found by following the horizontal line from this point of intersection to the left side of the chart.

LYONS FAIR

The annual fair in Lyons, France, will be held this year March 3 to 17. The main purpose of this fair is to develop trade, facilitate transactions, and to bring the manufacturers and their products to prospective buyers. American manufacturers, particularly those who specialize in labor-saving devices and machinery, are invited to participate. Full information can be obtained from Emile Garden, official delegate for the United States and Canada, 50 Church St., New York City.

Teaching Trades in a Technical School

Preparing Boys in the Milwaukee Technical High School to Fill Positions as Skilled Mechanics and to Enter Engineering or Technical Colleges

IN most high schools the educational program is planned with a view to preparing the boy to enter college, and as only a small percentage of the students have this opportunity, the majority are graduated without any special training for the vocations they later pursue. Realizing the seriousness of this condition, a number of cities have established technical high schools in which the student may not only be taught a trade but also obtain an education that will be of more value to him should he later enter an engineering or technical college than the subjects taught in the average high school.

A most successful and well-equipped technical high school is that in Milwaukee, Wis. This school was founded about 18 years ago by a number of forward-looking citizens, and later turned over to the Board of Education. Since then it has been enlarged to accommodate the continually increasing number of applicants. The following trades are taught in this school: Electrical, machinist and toolmaking, patternmaking, plumbing, carpentry and cabinet making, printing, and mechanical and architectural drafting. The courses are so arranged that a boy, on completing one of them, may be as proficient as any finished apprentice in the field, and in addition he will have an education as good as that of a high school graduate.

The success of this school is mainly due to the fact that the principal and all members of the faculty who teach trade subjects must be practical men who have had several years' experience in the trade they teach, as well as in teaching. The present article will outline the work of the boys who elect to learn the machinist trade in this school or to prepare themselves for taking a mechanical engineering course at some college.

Kinds of Students

Three distinct classes of boys are admitted to this school. The first class consists of boys who have finished the sixth grade and are mechanically inclined. These students receive vocational guidance through the medium of a variety of shop work and shop trips, and then select their future vocation by "self-determination," and not "pre-determination" on the part of their parents. After selecting their shop work these students are taught by male instructors in classes that are planned on the basis of a three-year junior high school and a three-year senior high school. The second type of students comprises boys who have been regularly prepared to enter high school and who desire to learn a trade while they are studying to enter an engineering or technical school.

The third class includes boys of sixteen years or over who desire to give up regular academic class work and prepare in the shortest possible time to enter the industries as skilled mechanics. There is a two-year trade course for these students, and they may enter at any time during the year. These boys have had an opportunity of deciding on a trade through manual training while in the grammar classes and may now devote seven and a half hours a day to learning it. The present article will deal particularly with this type of students.

Trade and Technical Instruction

The work of the school is divided into two departments—trade and technical. Graduation from a trade department depends upon the completion of a course of study planned for the particular trade that the student follows, including both technical and allied academic work. While such courses are laid out on the average basis of two or two and a half years of work, depending upon the length of day spent in the department, the student may progress as fast as his individual ability will permit, and is given a trade diploma upon the satisfactory completion of the required work, regardless of the amount of time spent in the school. He is then qualified to work as a skilled mechanic in his chosen field. For example, a student who has learned the plumbing trade must be qualified to pass the state examination for plumbers before he receives his diploma; and it is of interest to note that no graduate has ever failed to receive his state license at the first examination given by the state commissioners. Allied academic work in the trade departments is not given regular high school credit, but trade students may, with the approval of their teachers and the principal, elect to take any work in the technical department for which they have been qualified by previous education.

In the technical department, a junior high school diploma is given a student when he has satisfactorily completed a program of studies that covers three years and includes English, arithmetic, geography, mechanical drawing, bench metal and wood work, industrial and historical civics, algebra and general science. After the student has reached the age of sixteen he receives instruction in the shop work that he chooses.

The senior high school course also covers a period of three years during which the student is taught, in addition to the elected shop course, advanced algebra, biology, English, mechanical drawing, American history, German (elective), physics, chemistry, geometry, and trigonometry. Gymnasium work is elective throughout the entire course after the junior high school course. Mechanical drawing and some type of shop work are compulsory except for such students as have previously graduated from a trade department. Shop work in the technical school regularly occupies two periods a day and mechanical drawing, one period. Other studies usually require one period in class each day and home preparation besides. Pupils who graduate from

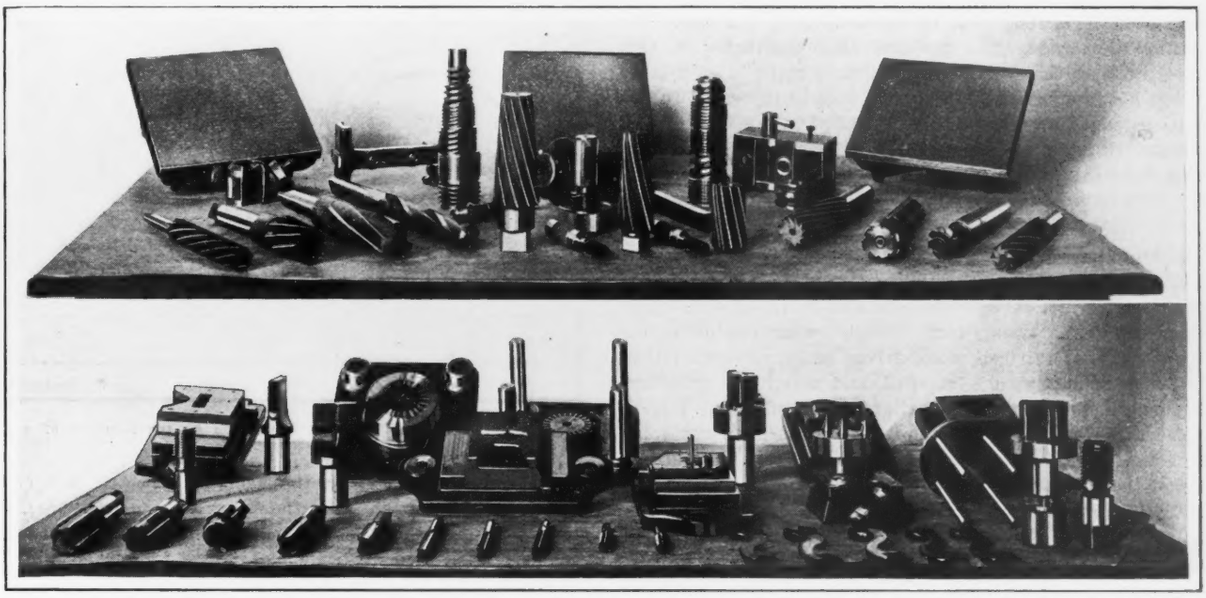


Fig. 1. Miscellaneous Collection of High-class Work made by the Students of the Milwaukee Technical High School

the technical department and are recommended by the principal, may enter the University of Wisconsin without examination.

Learning the Machinist Trade and Toolmaking

Boys who complete the two-year machine shop course are better all-around machinists than many who serve time as apprentices in the field. In the school the boys are given thorough instruction on practically all types of modern machines, and are taught individually by teachers who realize that if good machinists are not turned out, it will be a reflection on them and the school. No attempt is made to run the school on a paying basis, because if production work were undertaken, the tendency would be to keep the boys too long operating a machine on which they are proficient, instead of teaching them other phases of the trade with which they are unfamiliar.

When a boy is apprenticed to an employer to learn a trade, it is a matter of dollars and cents to the employer, and so the boy is kept on machines for a considerable period after he has learned their operation, in order that the employer may benefit financially as much as possible from the bargain. That is one reason why students in a school of this sort can learn a trade in approximately one-half the time required for apprentices in the field. Not all employers are conscientious as concerns their apprentices, and fail to instruct them thoroughly; again, in some large plants apprentices are often taught practices that are peculiar to that plant. When a boy completes his apprenticeship in such a plant he is not really skilled in his trade, and may experience difficulty in working at it for some other company.

Aim of Technical High School

In this high school the aim is to fit the student for the many lines of advance in the machinist trade, either in superior work, foremanship, experimentation, or other positions of responsibility. The course progresses through the following units of shop work: Lathe, milling machine, planer, slotter, universal grinding machine, bench, floor, tool- and die-making, tool forging, tempering, and heat-treating. Students operate, assemble, dismantle, and repair all kinds and classes of machines, and do the erecting whenever new machinery is being installed. They also follow courses in allied academic subjects which will be considered in detail later.

It will be noted that bench work is not taught until well on in the course. In the field and in some other schools it is quite common to teach the boy first the art of filing by making him square up with a file the sides and edges of a C-clamp or some similar part. This is always a wearisome job even for a finished machinist, and to have a student

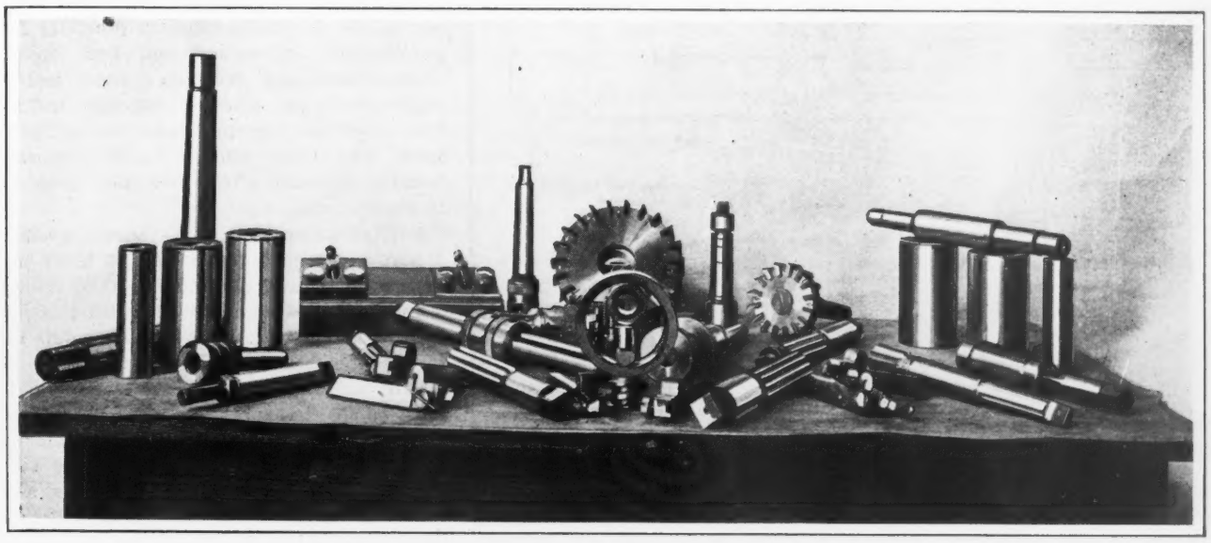


Fig. 2. Another Collection of Parts made by the Students

start with it usually results in dampening his ardor for learning the trade. The machine shop instructor in this school believes that the boy should start right in on a lathe so that his interest and enthusiasm may be increased rather than abated. The first lessons consist of instruction in centering work for a lathe, the results of inaccurately centering being fully explained.

Typical Work Taught in the School

Most of the work done in the school is put to a practical use. Typical orders are as follows: Six 14-inch swing engine lathes, 8 feet between centers and equipped with speed change-box, etc.; twenty-four 10-inch swing engine lathes with 5-foot bed; thirteen motor-driven patternmaker's lathes of 12-inch swing, with 8-foot bed, and seven tool grinders. All parts, including the gearing, are produced in the school. Before a boy receives his diploma he must have cut spur, bevel, spiral, and worm gears. He must make a pair of each of these types for assembly in a machine, as illustrated in Fig. 3, and it must be possible to rotate handwheel *A* easily in either direction without there being excessive backlash in any pair of gears. It will be seen that the drive is through worm-gearing *B*, miter gears *C*, spiral gears *D*, bevel gears *E*, and spur gears *F* to rack *G*, which is free to slide back and forth on the base. Although a boy makes this complete set of gears, only one of these mechanisms is assembled by every five students.

When a boy has progressed to the point where he can operate the various types of machines and realizes the need for accuracy in his work, he is taught toolmaking. Circular gear-cutters, hobs, reamers, drills, angular milling cutters, and similar tools are made, the students calculating all dimensions for themselves and setting up the machines for indexing, etc. The student must also harden and temper the tools in a department equipped with four gas furnaces and cyanide hardening and tempering baths. This department is provided with Brown electrical pyrometers, and there is also such equipment as a scleroscope and microscope for studying the hardness and structure of heat-treated parts. Jigs and fixtures of various types are also made and each boy must scrape a small surface plate. Many of the hobs and gear-cutters are sold to outside concerns.

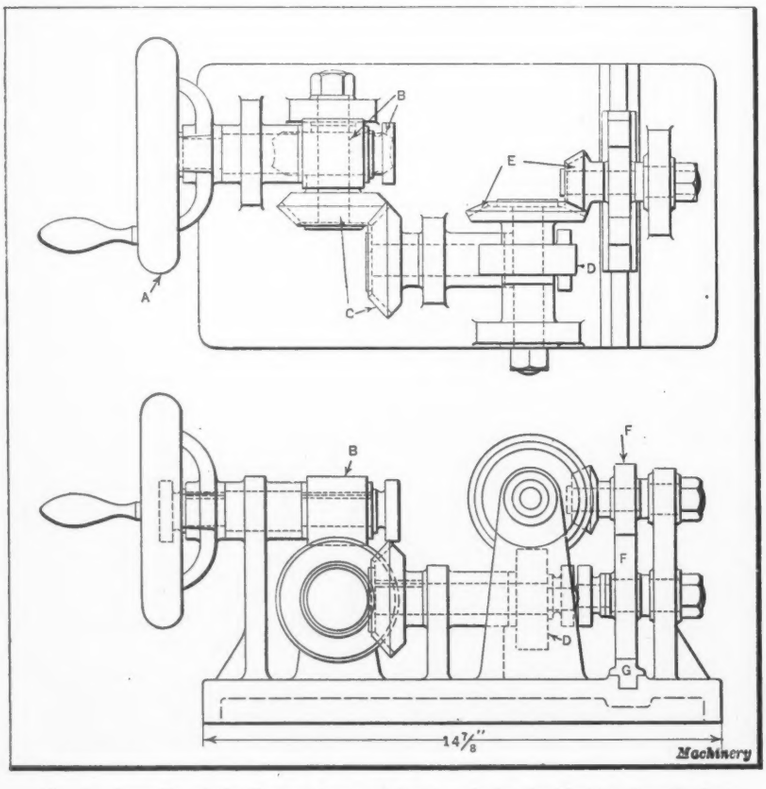


Fig. 3. Assembly of the Various Types of Gears made by the Machine Shop Students

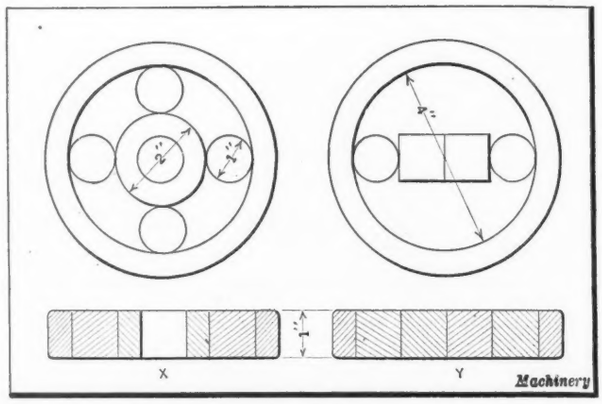


Fig. 4. Example of Accurate Work done by the Members of a Graduating Class

During the time spent in the shop, one month is served in the tool-crib so that the student will learn to appreciate the value of high-priced instruments and tools, and will become familiar with a system of caring for and keeping a record of tools that are given out to the workmen.

No regular schedule of work is followed in this school, as it is believed that none would be applicable to all boys; instead individual instruction is given in work for which each boy is best fitted. In order to show their ability the students of one graduating class made a set of rings and plugs, such as illustrated in Fig. 4. Each part is made of steel, hardened, ground, and lapped. The fit of each part is such that when they are assembled, as shown at *X*, it is possible to lift the outer ring without any of the parts slipping out, and yet the outer ring may be easily revolved on the plugs and inner ring. At *Y* is shown another assembly which is made without forcing the parts, and yet this unit also can be lifted by means of the ring or plugs without the latter slipping out of place. Between sixty-five and seventy boys take the machine shop course at one time.

Allied Academic Subjects

Boys who are learning to become machinists or toolmakers are taught the following academic subjects: Trade English, shop arithmetic, shop trigonometry, trade science, and mechanical drawing. Considerable stress is laid on the latter subject, the student being compelled to devote 500 hours to it during his course of from two to two and a half years. There are 750 hours per semester. The number of hours devoted to the other subjects is about as follows: Arithmetic, 150; English, 75; trigonometry, 80; and science, 60. In the shop arithmetic course, the boy is given such practical jobs as figuring out pulley and gear speeds, change-gears, and machining time, and in trigonometry he receives sufficient instruction to enable him to handle gearing problems. The trade science course comprises lectures on making iron and steel, problems in physics, etc.

English is a subject that seldom appeals to a boy, and it is often difficult to make him realize the value of studying this subject. When a student enters the English class, he receives an instruction sheet that points out to him the fact that in order to become an intelligent and well-trained craftsman he must be able to express his ideas clearly both orally and in writing. The boy may later go into business for himself, and so should know how to design and use business forms, such as checks, make out receipts and bills, itemize pieces and costs, etc. He should also know how to write a letter of application for a

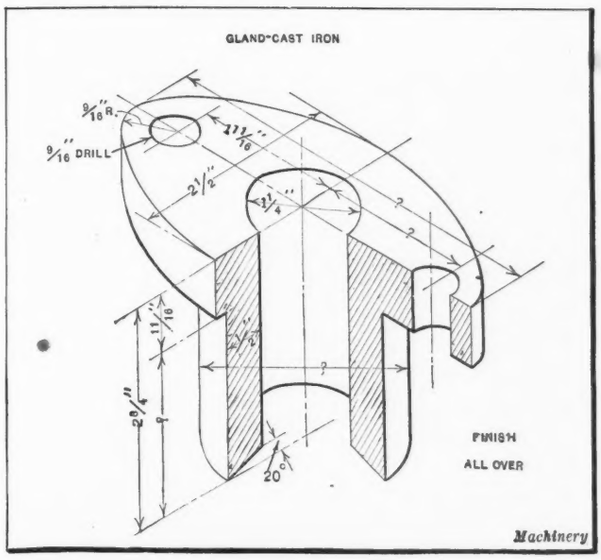


Fig. 5. Typical Sketch from which the Machine Shop Student develops a Mechanical Drawing

position and what constitutes a properly constructed advertisement for help. The course is planned to educate the student along these lines, and also to familiarize him with the proper spelling of words peculiar to his trade. There is no strict adherence to formal grammar; conversation between the teacher and student is about as it would be in a shop, except that no slang is used. Individual lessons are given in this class, too, so that nowhere is the progress of one boy retarded because of other boys not being able to keep up with him.

Drawing-room Instruction

In the drawing-room, both the patternmaking and machine shop students follow the same course. They are taught how to use the instruments and are then given geometric propositions and lettering exercises. The student is next given blueprints (such as illustrated in Fig. 5, which shows a sketch of a gland casting) from which to develop working drawings having a sufficient number of views, with dimensions, to permit of making the parts. Some over-all dimensions must be determined by the student, as for instance those indicated by question marks.

There is a model part for each of these drawings, and so when a boy is unable to visualize a part that he is developing, he is permitted to look at the model. The first drawings are made full size and then to smaller scales. Considerable free-hand sketching practice is also given. Pattern shop apprentices seem to grasp the principles of drawing quicker than the machine shop students, which is probably due to the fact that the former have more lay-out work in the shop.

During the last semester the boy makes an assembly drawing of a steam poppet valve from the different detailed drawings. No attempt is made to develop designers, as the sole purpose of the drawing course for boys who elect shop work is to teach them to read blueprints, a knowledge of which is so essential to foremen or shop superintendents; an attempt is made to instill into all boys the ambition to advance to higher positions. As far as possible the boy draws up parts on which he works during the hours spent in the shop.

At first many of the boys do not appreciate the value to a machinist of understanding the principles of mechanical drawing, but when they do, the majority follow the course with interest, and some have taken the full mechanical drafting trade course after graduating from the machine shop course. The boys are not compelled to make artistic drawings; however, stress is laid on the necessity of having drawings fully developed, dimensioned, and correct in all details.

The value of this school is evidenced by the constant demand for its graduates and by the satisfactory reports that come from concerns who have employed them. One of the graduates, who was only about twenty-three years old, was made master mechanic of one of the largest industrial plants in Milwaukee, at a salary of $300 a month, after working for the company about four years. Another graduate is a consulting engineer, several are machinery appraisers, and still others work in experimental departments. One boy entered a small shop without agreeing upon a wage, and in eight months' time was offered the foremanship.

Although the work of only the machine shop students has been outlined, the shop work of all the other trade students is fully as practical and intensive. Only graduates of the eighth grade or boys having an equivalent education are admitted to the mechanical drafting and architectural drafting trades. Boys in the technical department who complete the junior and senior high school courses receive practically as much machine shop training as the boy who is simply learning a trade and does not intend to continue his education at an engineering college. It will be apparent from the foregoing that the primary purpose of this school is to produce men who will be leaders in the industrial world, and not mere machine operators.

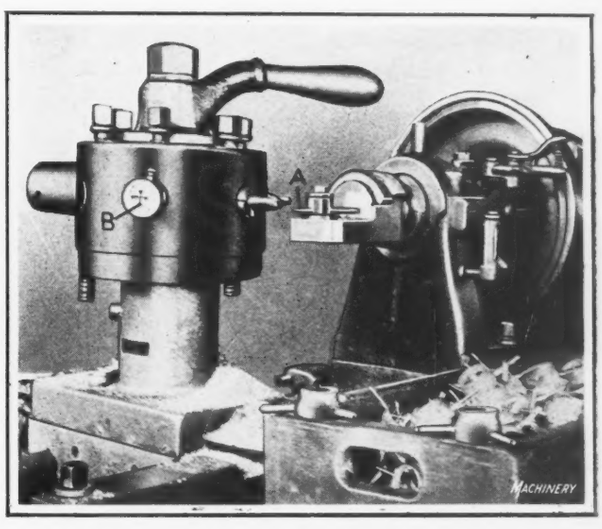
* * *

MACHINING TRANSIT LEVELING POSTS

By ROBERT MAWSON

The special tool set-up shown in the accompanying illustration is employed in machining the leveling posts for a transit telescope. The first operation on the leveling post castings is that of boring the 1 1/16-inch center hole. After the center hole has been bored, the casting is placed in the fixture shown, where it is located on a pin which fits the 1 1/16-inch finished hole. The work is located against a stop-pin which brings the shank *A* to be machined into the proper position. The turret is then advanced to the work so that a hollow-mill held in the turret is brought into contact with the work. This tool finishes the shank to a diameter of 0.157 inch. The turret is next withdrawn and revolved to the next position and the turned shank threaded with 48 threads per inch by the die shown at *B*.

The fixture is next indexed around 120 degrees, and the machining operations repeated on the next shank. The three positions, 120 degrees apart, are obtained by means of an indexing pin in the base of the fixture. The pin is backed up by a spring which exerts just enough pressure to hold the two parts in the indexed position during the machining operation. A number of leveling posts that have been machined by the use of this special tool equipment may be seen in the box at the front of the lathe.



Tool Equipment used in machining Telescope Leveling Posts

The Path of Roller Centers in Chains

By G. M. BARTLETT, Consulting Engineer, Diamond Chain & Mfg. Co., Indianapolis, Ind.

ONE of the first laws of physics is that every particle of matter tends to remain in a state of rest or of uniform motion in a straight line unless acted upon by some external force. All moving parts of a machine are subject to this law, and a definite percentage of the wear and tear in various parts of the machine may be traced directly to it. The effect becomes noticeable, however, only when the play in the bearings is sufficiently great to cause a rattle, or when certain transmission members, because of their nature, are not constrained to move in definite paths. Such is the case with belts, ropes, and chains.

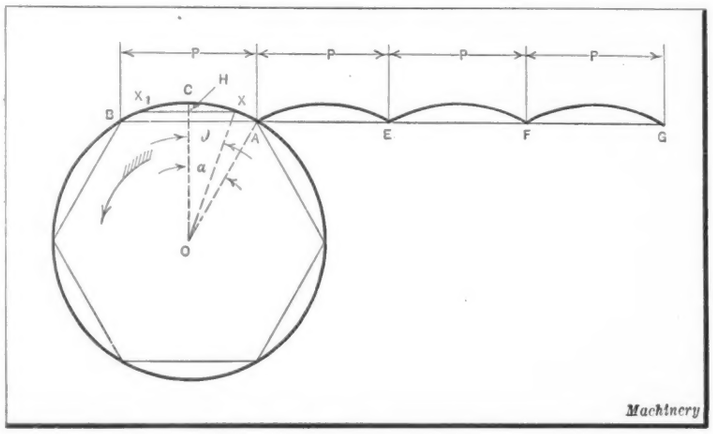


Fig. 1. Diagram used in explaining Action of Sprocket Chains

The behavior of a chain running at high speed is not the same as when moving slowly. A knowledge of the action of the chain at various speeds and under various conditions is of great assistance to the designer and is practically necessary if efficient drives are to be developed. The writer gives here the results of some investigations of the paths followed by the centers of the chain pins when approaching and departing from the sprockets both at high and low speeds.

Referring to Fig. 1, we have, in the following formulas,

P = pitch = AB;

N = number of teeth;

$$\alpha = \frac{180 \text{ degrees}}{N};$$

$$D = \text{pitch diameter} = \frac{P}{\sin \alpha};$$

S = revolutions per minute of sprocket;

V = horizontal chain velocity, in feet per minute =

$$\frac{NPS}{12} \qquad (1)$$

V_1 = velocity of any point on pitch circle, in feet per minute =

$$\frac{\pi DS}{12} = \frac{\pi PS}{12 \sin \alpha} \qquad (2)$$

H = a point on the sprocket having a velocity equal to the chain velocity. Now

$$\text{Cos } \theta = \frac{OH}{OX} = \frac{V}{V_1} = \frac{NPS}{12} \times \frac{12 \sin \alpha}{\pi PS} = \frac{N \sin \alpha}{\pi} \qquad (3)$$

and

$$OH = OX \cos \theta = \frac{D}{2} \times \frac{N \sin \alpha}{\pi}$$

$$= \frac{P}{2 \sin \alpha} \times \frac{N \sin \alpha}{\pi} = \frac{PN}{2\pi} \qquad (4)$$

As the chain pin travels from A to X, its horizontal velocity is less than that of the chain. At X the horizontal velocity is equal to that of the chain, and at points between X and X_1 the horizontal velocity is greater than that of the chain.

The value of θ, according to Formula (3) is found to be $0.576 \times \alpha$ for 10 teeth and $0.583 \times \alpha$ for 90 teeth. Its average value is about $0.58\,\alpha$. That is, the arc XC is always about 58 per cent of the arc AC.

$$\text{The half chord } HX = \frac{1}{2\pi} \sqrt{(\pi D + NP)\ (\pi D - NP)}$$

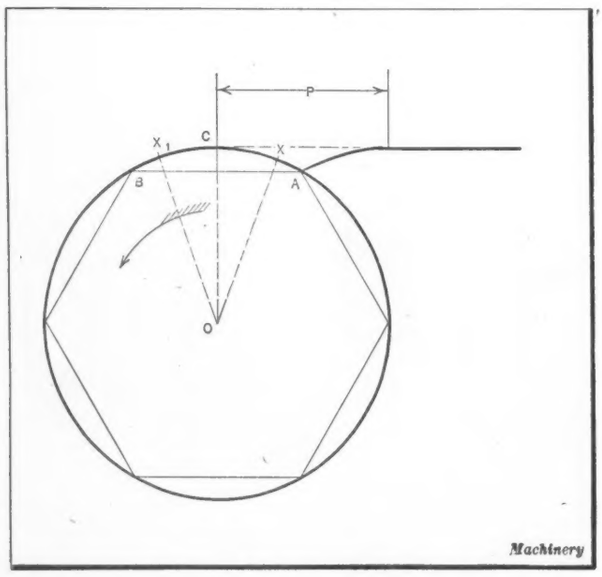


Fig. 2. Diagram used in explaining Conditions that cause Chain to move in a Straight Line

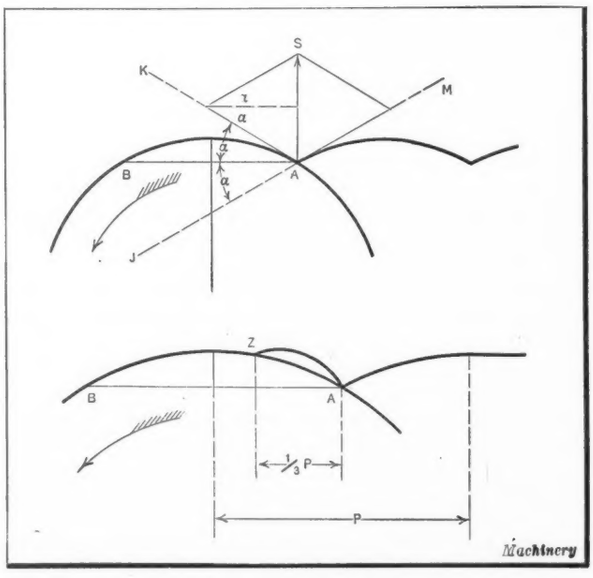


Fig. 3. Diagram showing the Effect of Impact on the Path of the Chain

Now if the driven sprocket and the masses attached thereto are of light weight, and if the chain itself is light, the motion slow, the load fairly heavy, and the chain dry, the path of the centers of the pins will be a series of arcs *AEFG*, as shown in Fig. 1, where the driven sprocket (not shown) has the same number of teeth as the driver, and the center distance is an exact multiple of the pitch. The lineal velocity of the pin-centers along this path is the same as the velocity around the pitch circle, or

$$V_1 = \frac{\pi PS}{12 \sin \alpha} \qquad (2)$$

But the average *horizontal* velocity of the pin-centers is less than this, or equal to $NPS \div 12$ as given in Formula (1).

If now the speed, the weight of the chain, and the weight of the driven sprocket or its appurtenances is increased, and the load is not too heavy, the inertia of the chain parts will urge every point to move in a path more nearly straight, as shown in Fig. 2, and also to move at a uniform velocity equal to $NPS \div 12$. Now A may be called the theoretical "point of impact." As the chain pin is passing from A to X around the pitch circle, the horizontal velocity of the chain is greater than the horizontal velocity of the wheel, and the sprocket cannot be said to be driving the chain during this period. But when the point X is reached, the horizontal velocities of the sprocket and the chain are equal, and between X and X_1 the horizontal velocity of the sprocket exceeds that of the chain, and if the straight portion of the chain persists in maintaining its uniform velocity there must be a certain amount of elasticity in the driving strand of the chain to take up this extra motion in the arc XX_1.

Now during the period of motion from X to X_1 the straight portion of the chain will have traveled a horizontal distance equal to $\theta P \div \alpha$ inches, and the sprocket will have traveled a horizontal distance equal to the chord XX_1 or $D \sin \theta$ inches, or $(P \sin \theta) \div \sin \alpha$ inches. The difference between these distances is

$$\frac{P \sin \theta}{\sin \alpha} - \frac{\theta P}{\alpha} = P\left(\frac{\sin \theta}{\sin \alpha} - \frac{\theta}{\alpha}\right) \text{ inches} \qquad (5)$$

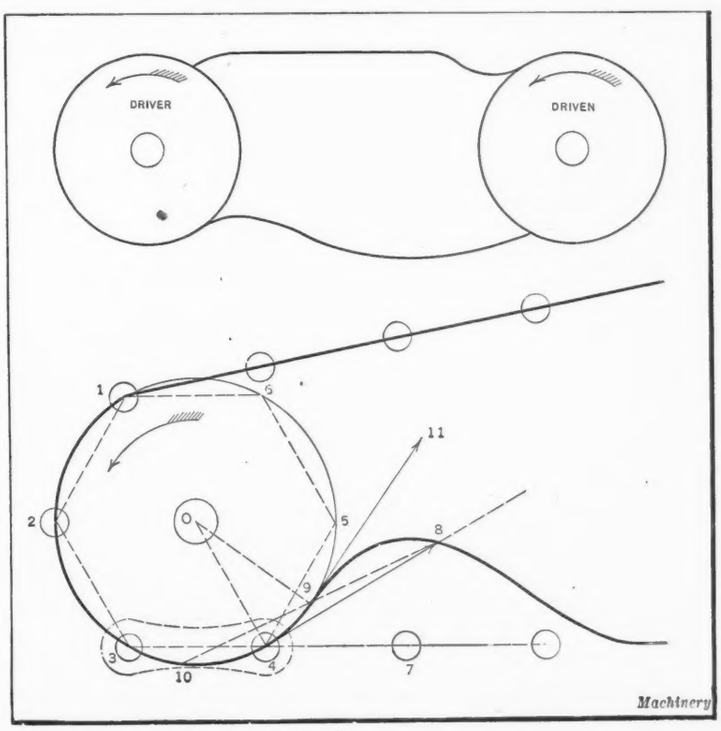


Fig. 5. Paths followed by Chain Center under Certain Operating Conditions

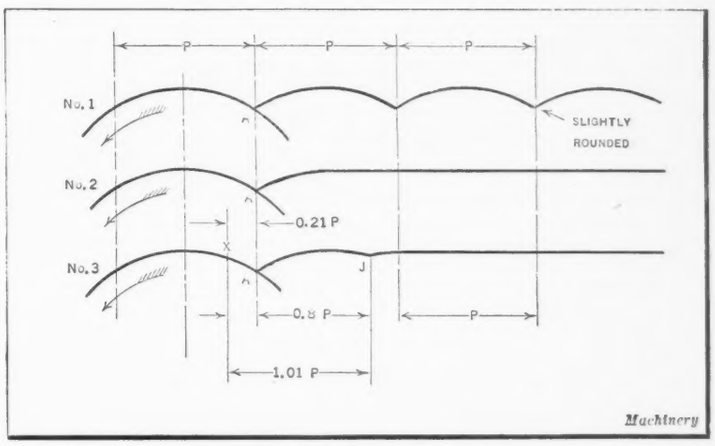


Fig. 4. Paths followed by Chain Center in Three Different Tests

and this is the expression for the required elasticity in the chain during the period of action from X to X_1. For 10 teeth this amounts to $0.0064P$; for 15 teeth it is $0.0028P$; and for 30 teeth it is $0.0007P$ inches. An approximate expression for this elasticity is $(0.64P) \div N^2$ inches.

The foregoing theory seems to be substantiated by the following three tests made in England, which were described in *Engineering*. Two 17-toothed sprockets of one-inch pitch were used; center distance, 30½ inches; horsepower, approximately 10; chain pull, approximately 230 pounds; chain velocity, 1420 feet per minute, and speed of sprockets, 1000 revolutions per minute.

In test No. 1 (Fig. 4) the chain was run absolutely dry, and the path of the pin-centers was obtained by allowing a pointer, attached to the forward pin of an outside link to pass over the surface of a wax plate, thus leaving a record of its path through space. Test No. 2 was the same as No. 1 in all respects except that the chain and sprocket were oiled. This oil evidently supplied the elasticity of 0.0022 inch that was required to change the path from a series of arcs to a straight line. The cushioning effect was supplied by four films of oil, that is, a film between the tooth and roller, one between the roller and bushing, another between the bushing and pin that are in engagement, and another between the bushing and the pin that follow the one in contact. If each film took an equal amount of the compression, this would amount to only 0.0006 inch per film.

In test No. 3 the pointer was placed in the rear pin of an outside link. In this case the path showed a slight dip located about $0.8P$ from the impact point A or a distance closely approximating the pitch, from the point X where the action theoretically begins. The only explanation of this seems to be that, since lubrication cannot affect the distance between the two pins on an outside link, when one is at X and the other at J, the drop takes place as a result of the difference between the horizontal velocities of the sprocket between A and X, and of the straight portion of the chain.

It should be noticed that in these tests the chain velocity is abnormally high, and the chain pull abnormally low. Under normal conditions of load and velocity the chain pins will always *tend* to follow a path similar to that shown in Fig. 1.

Effect of Impact

The chain roller theoretically comes in contact with the sprocket at the point A, as indicated in the upper diagram, Fig. 3. Before contact it is moving in the direction MA, and after contact it is moving in the direction AK. The impact tends to throw the roller in the direction AS with

a velocity equal to $2PS$, or the velocity of a point on the sprocket located at a distance of P from the center. When the load is light and the number of revolutions per minute is high, the roller will rebound for an instant, as shown by the test illustrated in the lower view. In this test the pitch was 1½ inches, the number of teeth in the driver was 10, and in the driven wheel, 30; the number of revolutions per minute of the driven sprocket, 1200; the chain velocity, 1500 feet per minute; horsepower transmitted, 10; chain pull, 220 pounds; and the center distance, 45 inches. In this test the chain was well oiled. The length of the arc of rebound was one-third the pitch. By altering the speed and load, the length of this arc was made to vary from $0.2P$ to $0.57P$.

Chain Path upon Leaving the Wheel

The diagram at the top of Fig. 5 shows the typical curves in the path of a chain as it enters and leaves the driver, and as it enters and leaves the driven wheel. The explanation of the wave at the point of leaving either wheel is as follows:

In the diagram at the bottom of Fig. 5 the numerals 1, 2, 3, 4, 5, and 6 represent the six teeth of a sprocket which is driving in the direction indicated by the arrow. Numbers 3-4-7 indicate the direction in which the center line of the slack side of the chain lies when the sprocket is not in motion. But if the sprocket is in motion, then roller No. 4 is just about to leave the sprocket. It is at this instant moving in the direction 4-8, perpendicular to 0-4, and its inertia will cause it to continue moving in that direction until other forces, such as the weight of the chain or the motion of the driven wheel, begin to pull it down. If no such forces should act until it reaches the point 8, then roller No. 2 will be at 10, and roller No. 3, which will be at 9, will tend to leave the sprocket in the direction 9-11 (perpendicular to 0-9). But the other sprocket is pulling the chain to the right, and gravity is pulling it down. The resultant of these three forces determine the character of the curve. This curve is deepest when the number of teeth is small, when the velocity is high, and when there is considerable slack in the chain. It occurs to a lesser degree at the point where the tight side of the chain leaves the driven wheel, and is more marked there when the load is light. It will also occur on idler wheels, regardless of whether they have teeth or simply consist of rollers.

We may summarize the subject of chain paths in the following statements:

1. Impact tends to throw a chain off its normal path.
2. To some extent the length of throw varies directly with the speed and inversely with the pull on the chain.
3. The average velocity of a chain as it passes from sprocket to sprocket is less than its velocity in passing around a sprocket.
4. The action of the sprocket teeth meshing with the chain links tends to give a variable velocity to that portion of the chain stretched between the sprockets.
5. The inertia of the chain tends to keep the links traveling in a straight path and at a uniform velocity.
6. As a result of points 4 and 5 the major portion of the driving strand tends to travel in a straight line tangent to the pitch circles, while the sections at the points of entrance and departure curve toward the point of impact.
7. As the velocity or amount of lubrication is decreased, or the chain pull increased, this smooth path tends to break up into a series of pitch arcs.

* * *

At the annual meeting of the Board of Directors of the Society of Industrial Engineers recently held in New York City, the following officers were elected: President, W. J. Sheehan, president of the Crystal Corporation, Detroit, Mich.; treasurer, Edward T. Miller, executive secretary of the United Typothetae of America; executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

INDUSTRIAL CONDITIONS IN GERMANY

From MACHINERY'S Special Correspondent

Berlin, December 6

There is no need of referring to the general conditions of the exchange situation and the value of the mark, because this is a subject well known to all who read the newspapers. It may not be as fully understood, however, that the collapse of the mark has created an almost total stagnation of trade, and that complete chaos rules in the financial world. There is no uniform method for making quotations or for invoicing. Some industries quote in gold marks based on the exchange value of the dollar; others, according to the gold-buying price of the Reichsbank.

To mention prices really means nothing, because sometimes prices, as expressed in marks, change as much as 50 per cent in a single day. This, of course, has had a very serious effect upon the industries, and there are now in Germany over 4,500,000 workers without employment. In the Rhine and Ruhr districts there are over 2,000,000 more out of work. The unemployed receive from the Government some assistance, but this is paid in money which practically has no value any more.

Owing to the constant change in the value of a mark, workers in many plants are paid several times a week, sometimes daily. Every employe is at least paid daily his "bread money," that is, a certain amount for obtaining the bare necessities in food. Even when a business is solvent, it is sometimes practically impossible to obtain the actual currency with which to pay wages and salaries. Prices for many things are no longer low in Germany, as compared with the world's market price. Coal, for example, when the world's market price was 22 gold marks per ton, was 38 gold marks in Germany. Many German factories are unable to compete in foreign trade because of the price of coal alone.

In the machine tool industry, the smaller works have been closed, and those that are still running are receiving no new orders. The machine tool center of Germany—Saxony—is in a political upheaval. The metal and machine industries of Saxony have always been very important. In 1912 they employed over 200,000 workers, and in 1922 close to 300,000. In the iron and steel industry, many plants have been shut down owing to lack of both export and domestic business. Those that are still working can scarcely raise sufficient money to pay wages. Only a very small percentage of the cutlery shops in Solingen are fully occupied, and the hardware industry in certain parts of Germany has come to a standstill.

Mining activities are limited, because there is no outlet for ore, and it is not practicable to store it. The locomotive-building plants are limiting their output. One of the largest firms in this field has been compelled to buy its raw materials and wheels from abroad, because of being cut off from domestic supply by the present political situation. In the electrical industry, generally supported to a large extent by export business, foreign competition is keen and foreign business therefore very quiet. The business in motorcycles has been brisk, and this is one of the few industries that has really retained its activity up to the present time.

The efficiency of labor has seriously decreased. In the mining industry, the output per worker is only 60 per cent of that previous to the war. The Siemens-Schuckert Works state that the output per employe is not quite 75 per cent of the pre-war output. This low efficiency per employe is due to the large number of non-producers now being employed. In former years Siemens & Halske, for example, employed four producers to one non-producer. Now they have less than three producers to each non-producer.

* * *

The Union of South Africa produces one-half of the world's annual production of gold, the output averaging between 8,000,000 and 9,000,000 ounces a year. In the first six months of 1923, the output was slightly above average.

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MACHINERY'S DATA SHEETS Nos. 25 and 26

HELICAL PHOSPHOR-BRONZE SPRINGS

Size of Wire, B. & S. Gage	Diameter of Wire, Inches	Constant	Mean or Pitch Diameter of Spring, Inches										
			1 5/8	1 1/2	1 3/8	1 1/4	1 1/8	1	7/8	3/4	5/8	1/2
1/4"	0.250	368	226 0.332 683	245 0.283 862	268 0.238 1127	294 0.196 1500	327 0.160 2060	368 0.126 2930	421 0.096 4370	For complete directions, see Data Sheet No. 23, December, 1923.		
3	0.2253	269	165 0.368 448	179 0.314 570	195 0.264 740	214 0.214 1000	238 0.181 1315	269 0.139 1935	306 0.107 2840			
7/32"	0.2187	247	151 0.379 400	164 0.323 509	180 0.271 660	197 0.224 880	219 0.182 1205	247 0.144 1710	282 0.110 2600			
4	0.2043	201	124 0.406 305	134 0.346 387	146 0.291 500	160 0.240 665	179 0.195 905	201 0.154 1305	230 0.118 1950	268 0.087 3090		
3/16"	0.1875	155	96 0.443 217	104 0.377 274	113 0.317 356	124 0.262 475	138 0.212 650	155 0.168 920	177 0.123 1380	207 0.094 2200		
5	0.1819	136	83.7 0.455 191	90.6 0.398 244	99 0.326 316	109 0.271 422	121 0.219 580	136 0.172 820	155 0.132 1230	181 0.097 1950		
6	0.162	100	61.5 0.512 120	66.7 0.437 153	72.7 0.367 200	80 0.303 264	89 0.245 363	100 0.194 516	114 0.148 770	133 0.109 1220	160 0.076 2100	
7	0.1443	70.4	43.4 0.575 75	47.0 0.490 96	51.2 0.412 125	56.3 0.340 167	62.6 0.276 228	70.4 0.217 325	80.5 0.167 485	94.0 0.123 768	112.6 0.085 1330	
8	0.1285	49.4	30.5 0.646 46	32.7 0.550 59	36.0 0.462 78	39.5 0.381 104	44.0 0.310 142	49.4 0.245 200	56.5 0.187 300	66.0 0.138 475	79.0 0.095 832	98.8 0.061 1600

MACHINERY'S Data Sheet No. 25, New Series, January 1924 Contributed by Joseph H. Sullivan

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CUT HERE

HELICAL PHOSPHOR-BRONZE SPRINGS

Size of Wire, B. & S. Gage	Diameter of Wire, Inches	Constant	Mean or Pitch Diameter of Spring, Inches									
			2 3/8	2 1/4	2 1/8	2	1 7/8	1 3/4	1 5/8	1 1/2	1 3/8	1 1/4	1 1/8
9	0.1144	35.3	15.2 1.549 9.6	15.7 1.390 11.3	16.6 1.240 13.4	17.6 1.100 16	18.8 0.977 19	20.1 0.850 24	21.4 0.732 29	23.4 0.625 37	25.6 0.524 49	28.0 0.431 65	31.2 0.350 89
10	0.1020	25.0			11.76 1.382 8.4	12.5 1.232 10	13.33 1.083 12	14.28 0.943 15	15.38 0.814 19	16.66 0.693 24	18.18 0.582 31	20.0 0.481 41	22.2 0.390 57
11	0.0907	17.6					9.3 1.200 7.8	10 1.057 9.6	10.8 0.912 12	11.8 0.779 15	12.8 0.652 19.8	14.0 0.539 26	15.6 0.437 36
12	0.0808	12.43						7.10 1.192 6	7.65 1.027 7.5	8.29 0.875 9.5	9.05 0.735 12	9.94 0.607 16	11.05 0.492 23
13	0.0720	8.80							5.41 1.150 4.7	5.86 0.984 6.0	6.40 0.824 7.75	7.03 0.680 10	7.82 0.552 16
14	0.0641	6.19								4.12 1.080 3.75	4.50 0.927 5	4.95 0.768 6.4	5.50 0.620 9
15	0.0571	4.36									3.19 1.040 3	3.50 0.860 4	3.90 0.700 5.6
16	0.0508	3.09										2.47 0.965 2.5	2.75 0.783 3.5
17	0.0453	2.15											1.91 0.884 2.16

Of the three values given, one above the other, in the table, the top value gives the load in pounds required to compress the spring solid; the second value gives the movement per coil in inches, when the spring is compressed from its free height to solid; and the third value is a figure which, if divided by the number of active or working coils in the entire spring, gives the load in pounds required to compress the spring 1 inch. The "constant" in the third column, if divided by the pitch diameter of any spring not specified in the table, gives the load that will compress the spring solid. For complete directions, see Data Sheet No. 23, December, 1923.

MACHINERY'S Data Sheet No. 26, New Series, January 1924 Contributed by Joseph H. Sullivan

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Notes and Comment on Engineering Topics

The largest ship driven by oil engines instead of steam engines or turbines is now under construction in England. It will be the first trans-Atlantic passenger liner provided with Diesel engines, and when completed will enter the service of the Swedish-American line. The engines will develop 16,000 horsepower. In the last few years, the number of ships provided with Diesel engines instead of steam engines has been constantly increasing.

A useful application of the airplane is found in the facility with which aerial photographs can be taken for the purpose of mapping large territories comparatively quickly. A map is now being prepared of New York City, made up on the basis of 2000 photographs that have been taken from airplanes. Approximately 625 square miles will be mapped in this way. The airplanes taking the photographs flew about 3000 miles in the course of this work.

In an article in *Aviation*, Colonel A. Crocco points out that it is commercially possible to use helium gas for airships, and that the available quantity of helium that can be produced in America would be sufficient to run 150 airships of average size. To produce the required amount of helium, the initial outlay for plant and equipment would be $70,000,000. It is evident that airships must prove themselves of greater value than they have so far before financiers will consider it safe to make such an investment.

In a paper relating to the strength of pipe provided with reinforcing rings, when employed in large hydro-electric installations working under high heads, read before the British Association by Professor Gilbert Cook, it is shown that it is possible to allow higher working stresses in the reinforcing rings than would be safe for the pipe, and for this reason a reinforced pipe can be made lighter than a plain pipe, provided the rings are sufficiently close together. The conclusions are based on the stresses in reinforced pipe in a pipe line used in connection with the Los Angeles power station.

The committee recently appointed by the American Engineering Standards Committee for developing standards for bolt, nut, and rivet proportions under the sponsorship of the American Society of Mechanical Engineers will consist of 43 members, 17 of whom represent producers, 24 consumers, and 2 general interests. The subjects that will be dealt with in this standardization are: Large and small rivets; wrench heads, bolts and nuts; slotted-head products; brake bolts and nuts; carriage bolts; special bolts and nuts for agricultural machinery; body dimensions and material; and nomenclature.

Engineering is a young profession and is still in a state of flux. It is not bound down by tradition or precedent, but has the virility of youth. It has the courage, the energy, and the orderly and creative mind essential to the solution not only of its own problems but of all the great problems of the industrial world. Upon the satisfactory solution of these problems depend the prosperity and peace of the world and the progress of the race. The responsibility is great, but we proceed with confidence that the profession will ably meet its obligations.—*John Lyle Harrington, past-president, American Society of Mechanical Engineers.*

By covering the tops of automobiles with cloth, the outside of which is painted with a black composition, 90 per cent of the sun's rays are absorbed and practically one-half of this heat is radiated on the under side of the cloth. Experiments in progress at the Bureau of Standards show that a coating of aluminum paint applied either to the outside or inside of such tops reduces by 50 to 60 per cent the intensity of the heat radiated from the under side of the cover into the interior. In this connection it might also be pointed out that the painting of steam radiators with aluminum paint is one of the most effective means of preventing the radiators from giving out the amount of heat that they otherwise should.

A world power conference (having nothing to do with military or naval power, but entirely pertaining to the economical and efficient operation of power plants) will be held in London, June 30 to July 12, in connection with the British Empire Exhibition, which is to be held at Wembley, near London. Many papers relating to steam generation, steam engines and turbines, hydro-electric installations, railroad power problems, standardization, and engineering training will be presented. A great many American engineers will be present at the conference, and the American committee contemplates contributing about thirty papers to the technical discussions. Further information may be obtained by addressing the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

Mining operations frequently require shafts to be sunk to a depth of over one mile. The deepest mine shaft in the world is located in Brazil and is known as the Morro Velho mine. This has been operated continuously since 1834 for gold mining, and is now 6726 feet below the surface at the top of the shaft. The next deepest mine is in the Kolar gold fields in India, where one shaft descends 6140 feet; in South Africa there is a shaft 6100 feet deep. The deepest shaft in the United States is a copper mine in the Lake Superior region, known as Tamarack No. 5, which is 5308 feet deep, and the bottom of which is 4100 feet below sea level. The temperature of the rock at the lowest level of the Brazilian mine mentioned is 117 degrees F., and the miners work in an air temperature of 98 degrees F., air being forced down into the mine from the outside.

Over $100,000 will be expended for research pertaining to engineering education by the Carnegie Corporation of New York. The research will be conducted under the direction of the Society for the Promotion of Engineering Education, and about $25,000 of the amount will be made available for this work during the present year. The Carnegie Corporation has recognized the importance of a more thorough study of the aims, objects, and methods of engineering education, with a view to determining the needs for the future development of engineering training. It is intended especially to determine definitely the objects of engineering education, and the fitness of present-day courses for preparing the student for his profession. The study will point out such modifications or developments as would seem to make for a sound, well balanced course bringing results that will most definitely fit the student for his place both in the industrial field and in the community. The study will also include a comparison with the best engineering schools in Europe.

Editorial

SHOP TRANSPORTATION

Economies are still possible in many shops and factories in the handling of materials and finished products. In the distant past, when unskilled labor was cheap, the shop transportation problem did not present so many difficulties; but today the progressive manager must study his shop transportation costs carefully and determine to what extent the installation of mechanical appliances for moving materials and finished products within the shop, is warranted.

An article recently published in the Journal of the American Society of Mechanical Engineers contains the findings of a committee appointed by the society to devise a formula for determining approximately when mechanical material-handling devices are likely to prove profitable. In this article it is stated that the factors which must be taken into consideration in calculations of this kind are, mainly, the present labor cost and the labor cost when mechanical devices are used, the cost of power and supplies when mechanical means are employed, the possibility of increased production through improved means of handling materials, the initial cost of the mechanical equipment, its life, and the cost of repairs. When all these factors have been considered, it is comparatively easy to determine how large an investment in mechanical appliances for moving materials is warranted.

Many managers have reached the conclusion that money can be saved and production increased by the use of electric trucks, hoists and similar mechanical devices, as is shown by the number of moderate-sized shops so equipped. It is no longer only the large shop that benefits from the use of these labor-saving means. Sometimes power trucks may not be required, but a great saving in time and effort is made by employing various types of lift-trucks, together with special trays or platforms in or upon which the material is loaded.

Generally speaking, it is more difficult to determine the actual saving resulting from improved means of handling materials than from improved machining methods. In the case of a certain part made on a machine tool it is easy to determine the time required by two different processes. In the handling of materials it is not so easy to make actual time studies, and the problem should be examined from a broad viewpoint, including the entire shop transportation system, rather than by examining separate items.

* * *

STARVING THE PATENT OFFICE

Considering that the industries of the country provide the largest part of the income of the national government, Congress might well provide adequately for so vital a service to them as the United States Patent Office renders, and divert a moderate percentage of the national income to provide efficient patent service. Instead of this, for many years Congress has squeezed money out of the Patent Office; in the fiscal year ending June 30, 1922, the net profits turned into the national treasury being $172,000. This profit was obtained by resolutely refusing to increase the meager salaries paid the staff twenty or thirty years ago, so that there were continual changes in the personnel. As a result, at times there have been 75,000 patent applications not acted upon, and the staff is now 66,000 applications, or more than a year, behind in its work. The appropriation for 1922-23 was slightly increased, so that a few more examiners could be employed, but the additional amount was not sufficient to handle the work in arrears, and unless the appropriation is increased further, five years must elapse before the work will have gained in volume so that new applications can be handled immediately upon receipt.

The Patent Office urgently needs more buildings, as the first section of the present structure was erected in 1840, and the last section in 1867. The lack of fireproof storage for the original records in patent applications makes it necessary to store them on wooden shelves, and a bad fire might completely destroy all the official records of patents issued, other than the certified copies in the hands of the patentees themselves.

The Patent Office also carries a stock of patent reprints worth $3,000,000 at production cost, the sale of which yields a net profit of nearly $100,000 a year, which are all stored on wooden shelves on six different floors in the Patent Office building, requiring stock bins with some 1,600,000 pigeon holes. A serious fire might destroy this stock of 50,000,000 copies, causing, besides the loss in money, great inconvenience to thousands of manufacturing concerns throughout the country who depend upon this information.

Inventors and manufacturers who find the constant delays in the Patent Office expensive and inconvenient should bring pressure to bear upon their members of Congress to provide an adequate appropriation for this work, and to erect a fireproof storage building in which the records and patent paper reprints could be kept safely.

* * *

THE PRACTICAL VALUE OF STANDARD AND SPECIAL MACHINE TOOLS

Users of machine tools who manufacture in quantities on the interchangeable basis are divided as to the advantages of special machinery over standard machine tools. There is little to be gained by discussing the merits of standard and special machine tools except in their relation to a specific shop operating under given conditions, as both types of machines serve distinct requirements.

The single-purpose, special machines have proved their value for the interchangeable manufacture of parts in quantities. An important feature in connection with this type of machine is that the simplified design possible in such machines renders them more suitable for operation by semi-skilled labor. While the range is more limited than that of standard machines, this is offset in many types of special machines by the greater accuracy possible, because of the fewer working parts used. The simplified design often makes it possible to build a special machine at a first cost which is actually less than that of a machine tool of wider range, provided a sufficient number of special machines are required.

The standard machine, on the other hand, has a broad field when the conditions are such as to demand an equipment more flexible than that provided by the single-purpose type. When there are frequent changes in the design of the product of the shop, the wider range of the standard machine allows it to be immediately adapted to any reasonable variation in the product. In such cases a special machine must often be changed materially, and sometimes actually discarded; in which case it would have but a small second-hand value as compared with the standard machine.

Both those who speak for the special machine and those who champion the standard machine tool in a measure are justified, because the product of the plant and the quantity of output must determine whether single-purpose or standard machine tools are to be used. It is true that in the large automobile plants, in the sewing machine industry, in the typewriter shops and in other fields where the output is large and changes in design are seldom made, special machines have been installed that save thousands of dollars daily. But in shops where the production is not highly standardized, where changes are frequent or the number of similar parts made is small the standard machine tool is the more economical type. Judgment alone, on the part of those responsible for production, can determine when one type or the other should be installed. Both are equally necessary for efficient and economical production in the machine shop field.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, December 12

THE latest reports from practically all the industrial districts confirm the more hopeful accounts that have been current during the last few weeks. There is a feeling of much greater confidence throughout the iron and steel industries, and these usually form a trustworthy barometer as to the state of trade generally. In a large number of industries, manufacturers are receiving an increasing number of inquiries and, speaking generally, are feeling justified in contracting for supplies over more extended periods.

Machine Tool Industry

The machine tool industry is beginning to feel the benefit of the improved conditions and in the last two or three weeks practically all centers of the industry have shown a growing confidence that has been engendered by more tangible proofs than have come to hand for many months. In the Manchester district inquiries are plentiful, and some substantial orders have been placed with machine tool builders; these include a large percentage of new orders from India, the Colonies, and the Continent. Grinding machines of special types figure largely among these orders. There is an increasing demand for large turning and boring machines, and about half the orders are for overseas customers. The automobile industry continues to be a good customer, and one well-known firm has just placed an order for a number of special machines that are required to meet the demands for next years' output.

The Scottish machine tool builders have been hit as hard as any others, but here also the number and varied character of the inquiries show a definite improvement, especially as the majority are from home users who have orders to place. Radial drilling machines, vertical boring mills, horizontal boring and milling machines, and vertical drilling machines are all being inquired for from a wide variety of the engineering trades.

In Birmingham and the surrounding districts machine tool makers are noticeably more active. Dealers who have, up till now, taken little in the way of machine tools have now placed some fair stock orders, and this is a particularly welcome sign of an increased belief in the prospects of immediate business. There is a steady demand for turret lathes and light drilling machines, as well as for the smaller types of cylindrical grinding machines and center lathes. A number of machine tools are in hand for Indian railways and also for Australia. Electrical engineers in the home market are taking a fair quantity of drilling machines, milling machines, and turret lathes. Firms that undertake the manufacture of special machines are well employed. In this district second-hand machine tools are again changing hands, but at more adequate prices than ruled at the time of government disposal a year or two ago.

Taking the country as a whole, it is safe to say that 50 to 60 per cent of the normal working force of the machine tool industry is being maintained, but this percentage has a tendency to increase as a result of railway schemes, the revival of shipbuilding and the steady growth of the automobile market.

Exports and Imports of Machine Tools

There was a sudden jump in the exports of machine tools during October, the increase amounting to about 60 per cent in tonnage and 50 per cent in value as compared with September. The export tonnage in October amounted to 1675, the largest monthly shipment since July, 1921. The value of this tonnage was £153,436. The imports were maintained at about the average monthly figure for the current year, the tonnage being 380 and the value £53,349. The value per ton of exported machine tools fell from £105 in September to £92 in October, whereas the value per ton of imported machine tools rose from £108 in September to £140 in October. The October returns are the first that have pointed to a reversal of the downward tendency that has been manifest throughout the year.

By far the largest customer for British machine tools during the quarter ended September 30, was India; that country bought machine tools to the value of about £100,000. Australia was the next best customer, with about £25,000. Other good customers were France, Belgium, Japan, South Africa, Spain, Canada, and New Zealand. America was the largest foreign seller in the British market during the quarter ended September 30, selling machine tools to the value of about £55,000, while Germany in the same period sold about £42,000. Next in order came France with about £5000.

General Engineering Field

The number of trades in the engineering industry that cannot report decidedly improved conditions are now the exception instead of the rule. Locomotive builders have received further important orders, and the same is true of railway car builders. Railway equipment and rolling stock shows an expanding market in British Dominions; the outlook for electrical engineering firms is encouraging, and makers of heavy oil and Diesel type engines for power generating plants are very busy.

Considering the time of the year, the automobile industry is well occupied. Most works are actively preparing for the next season, and there is every indication that all previous records of production will be exceeded. Light car manufacturers are placing large advance contracts for parts and raw materials, to cope with which several of the contracting parties are making large extensions to their factories. One well-known firm of gear specialists is building and equipping a new works exclusively for the production of back axle units. Motorcycle and bicycle manufacturers are still handling a large volume of business, and it is not unusual to find works running over-time on orders for export.

Makers of textile finishing machines are almost inundated with inquiries from abroad. There has been more activity in this section of engineering during the last few weeks than for at least eighteen months. The textile machinery trade generally, which had such a marked falling off, has recovered somewhat recently, but in no other section to the same extent as for finishing machinery. The makers of paper mill plant are also in a prosperous condition.

Shipbuilding

The settlement of the boilermakers' dispute the end of last month has altered entirely the outlook in the shipbuilding centers; men are rapidly being absorbed and already a greater percentage of men are in employment than might have been expected after such a long stoppage. Many yards that were working on short time before the lock-out are now able to resume work under full-time conditions. On the Clyde it is reported that there are 460,000 tons under construction, a tonnage nearly equal to that in hand in America, France, Holland, and Italy together. Yards in other shipbuilding centers also show increased activity.

Remedying Faults in Sprockets

By JOHN S. WATTS

IT is a simple matter to make a sprocket that can be used with a detachable link belt. Practically every jobbing shop has sprocket patterns for chains of various sizes, but while the sprockets produced from such patterns apparently function properly at first, both the sprocket and the chain have a short working life because of excessive wear. In order to insure satisfactory operation, the pitch

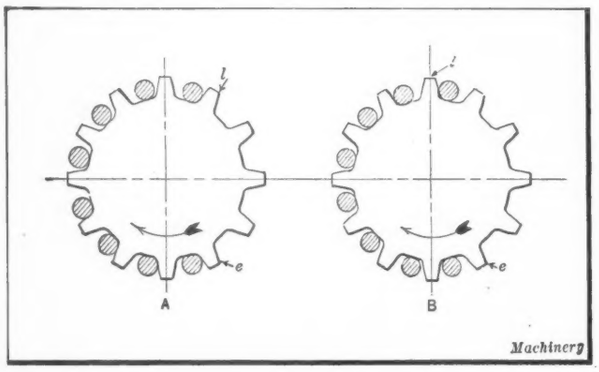

Fig. 1. Diagrams illustrating Action of Link-Belt Sprockets and Chain

of the chain and the sprocket must be correct. The change in pitch caused by wear, however, is one of the troublesome factors that cannot be entirely eliminated. Even if it were commercially possible to produce a sprocket wheel that would have exactly the desired pitch, it would still be necessary to make provisions for the varying pitch of the chain itself, which becomes greater when the chain wears, as well as when it stretches under load.

As it is impractical to make the pitch of the sprocket equal to that of the chain, the problem is to determine whether it would be better to have the pitch of the sprocket larger or smaller. The effect of having the sprocket pitch either larger or smaller than the normal pitch of the chain links will first be considered.

Effect of Changing Pitch of Driver and of Follower

Referring to Fig. 1, the sprocket shown at *A* has a smaller pitch than the chain. If this sprocket is used as a driver, the entering tooth at *e* will have to force its way into the chain link. This will cause excessive wear between the tooth and the chain.

At *B* is shown a sprocket having a larger pitch than the chain. In this case, the driving sprocket will take the load on the leaving tooth *l*, and the chain will seat quietly on the entering tooth *e*. The chain clears the teeth at the entering point, and appears to slip back gradually until it comes in full contact with the last tooth as shown at *l*. If the working faces of the teeth are properly shaped, the chain will be released quietly or without interference from the point of tooth *l*. It is evident, then, that the pitch of the driving sprocket should be greater than the normal pitch of the chain, as shown at *B*. However, the pitch should be increased only enough to permit the entering tooth *e* to clear the chain. Too great an increase of the pitch of the sprocket might prevent the chain from clearing the sprocket teeth at the leaving point.

In considering the effect obtained by changing the pitch of the follower or driven sprocket, it is assumed that the sprocket *A* is being driven or rotated in the direction indicated by the arrow, through the pull exerted by the chain. The load would be gradually taken up by the teeth as they approach the point *l*, at which the chain leaves the sprocket. The chain in this case would seat quietly on the sprocket at the entering point *e*. With the sprocket pitch increased, as illustrated at *B*, the chain would be forced to wedge itself into the sprocket at the entering tooth at point *e*, thus causing undue wear and noise.

Advantages Gained by Change in Pitch

From the two cases considered in the preceding paragraphs, it is evident that the follower sprocket should have a pitch somewhat smaller than the pitch of the chain. Care must be taken, however, not to decrease the pitch too much, as this would prevent the chain from clearing the sprocket teeth properly at the leaving point. With the pitch of the follower sprocket decreased the proper amount, the chain will seat quietly and have no clinging or interfering action at the leaving point. In the case of the driving sprocket, the preceding considerations would tend to show that the pitch of the driver should be greater than that of the chain.

This would seem to indicate the necessity for having two sets of patterns for each size of sprocket. However, this practice would be rather expensive, and there would always

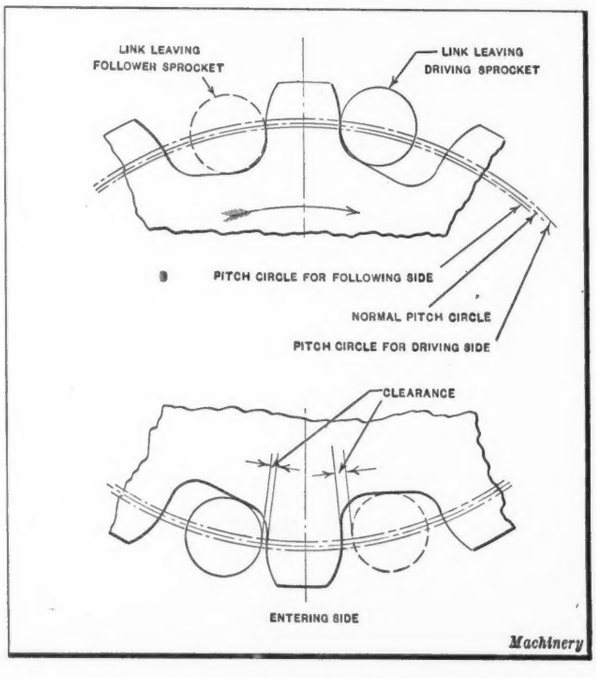

Fig. 2. Diagrams illustrating Principle of Improved Sprocket Design

be the danger of getting the sprockets mixed, so that a driving sprocket with its increased pitch might be used as a follower sprocket, which should have a smaller pitch. The results of such an error would be more detrimental than the use of sprockets having pitches that approximate the normal chain pitch. This difficulty can be overcome, however, by making each sprocket in such a way that it will have two different effective pitch diameters.

Improved Sprocket Design

In the upper view of Fig. 2 is shown the position of the links of a chain at a point where the chain leaves the sprocket. The lower part of the illustration shows the links

entering or seating on the sprocket. The full circles represent the links on the driving sprockets, and the dotted circles the links on the follower or driven sprocket. It will be seen that the links on the driving sprocket are located on a larger pitch circle than the links on the follower sprocket, so that the pitch of the sprocket measured on a pitch circle passing through the chain links will be larger than the normal pitch in the case of the driving sprocket, and less than normal in the case of the follower sprocket. In both cases, it will be noted that the links clear the teeth when entering.

Sprockets made as shown in Fig. 2 are theoretically correct for use as either drivers or followers. They must, of course, be assembled properly on their respective shafts; that is, they must always be rotated in one direction. This can be easily taken care of by having an arrow cast on the sprockets to indicate the direction in which they should be rotated. Both the driver and the driven sprockets should be rotated in the direction indicated by the arrow.

Generally speaking, the amount of increase or decrease in the pitch diameters should be just great enough to permit the chain to clear the entering tooth. If the pitch circle of a sprocket of average size is made ⅛ inch larger in diameter than the normal pitch diameter for the driver, and the same amount smaller for the follower, a clearance of about 3/16 inch on the entering tooth will be obtained, assuming that the chain is in contact with half the circumference of the sprocket. This clearance should be about right to allow for the unavoidable irregularities in the castings, but the effect of the stretching and wearing of the chain links is still to be considered.

As the chain wears, its pitch will be increased, and the effect of wear on the driving sprocket will be that of reducing the clearance on the entering tooth, but the link cannot come in contact with the tooth until the wear on each tooth is equal to the clearance, or in this case, 3/16 inch. Hence, for chains smaller than size No. 83, a clearance of 3/16 inch should be sufficient, but for chains heavier than No. 83, the clearance should be more, say ⅜ inch, which would call for an increase of ¼ inch on the pitch diameter. It should be borne in mind that the number of teeth in a sprocket does not have any effect on the amount of clearance. The clearance is affected only by an increase or decrease in the pitch diameter. The clearance will always be equal to one-half the difference between the pitch diameter of the sprocket and the normal pitch diameter multiplied by 3.1416. In the case of the follower sprocket, the wear will tend to increase the clearance on the entering tooth.

* * *

PROPOSED REDUCTION IN SECOND-CLASS MAIL RATES

Representative M. Clyde Kelly of Pennsylvania, a member of the Post Office and Post Roads Committee, has introduced in the House of Representatives a bill to reduce the postal rates on newspapers and periodicals. It is stated that the Post Office and Post Roads Committee, of which Representative W. W. Griest of Pennsylvania is chairman, is favorable to a reduction in second-class mail rates. In connection with the introduction of this bill, Representative Kelly explained that, with practically no exception, war taxes have been removed from all other industries and he stated that it is highly discriminatory to make the publishers of the country pay the present high postal rates, which are unjust and unfair both to them and to the subscribers.

The Kelly bill provides for the repeal of the last two increases which were made under the war revenue law of 1917. The proposed measure retains the present zone system of postal charges, but reduces the amount of charge from the fourth advance, effective July 1, 1921, to the second advance in rates which became effective on July 1, 1919. The repeal of the last two increases would still give the Government 175 per cent more than the pre-war rates.

CONVENTION OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The annual meeting of the American Society of Mechanical Engineers held December 3 to 6, at the Engineering Societies' Building, New York City, was attended by nearly 2000 members and guests. It has become necessary to divide the convention into many separate sections because, as the society now comprises over 17,000 members, it is natural that many special subjects must be dealt with that are of interest to one group but foreign to another. Thus, at the meeting just held there were special sessions on machine shop practice, management, education and training for the industries, oil engines, aeronautics, water measurements, steam power, hydro-electric power, steam table research, railroads, coal storage, textiles, refrigeration, ordnance, and forest products.

At the machine shop practice session a paper was read by Douglas P. Cooke, president of the Boston Pressed Metal Co., Worcester, Mass., on "Pressed-metal Engineering." This paper contained a brief analysis of the growth of the pressed-metal industry, and outlined the methods whereby engineering and sales promotion work can be coordinated to enable this industry to develop far beyond its present state. A paper entitled "The Development of Modern Stamping Practice" was presented by W. W. Galbreath, president, and John R. Winter, general superintendent of the Youngstown Pressed Steel Co., Warren, Ohio. This paper outlined the history of pressed metal and emphasized its growing importance.

A progress report was presented by the A. S. M. E. Special Research Committee on the cutting and forming of metals, prepared by the secretary of the committee, Clarence A. Beckett. This report was entitled "Progress Report on the Present Status and Future Problems of the Art of Cutting Metal," and was presented by H. B. Blood, general manager of the Pratt & Whitney Co., Hartford, Conn., who is chairman of the committee. This report reviews the present knowledge concerning the elements entering into the process of cutting metals. It states that the art in the design of cutting tools and its relation to the character of the work produced and the time required is practically where Dr. Fred W. Taylor left it twenty years ago.

The report proceeds to record the sizes and shapes of tools used by different experimenters, and then specifically deals with the materials composing the cutting tool, the design of the cutting tool, and the action of cutting fluids. It also deals with present practice and methods of testing cutting tool materials and materials to be cut, and contains the recommendations of the committee relating to the problems to be considered in research work and the methods of financing research problems. Finally, a summary of research work on the art of cutting metals is given, containing a historical review and covering a number of the more important series of experiments that have been conducted during recent years. A complete copy of this report may be obtained by addressing the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

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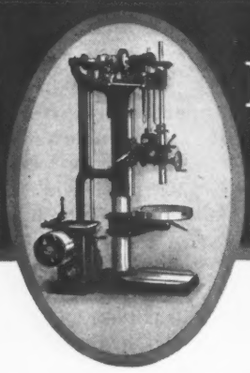
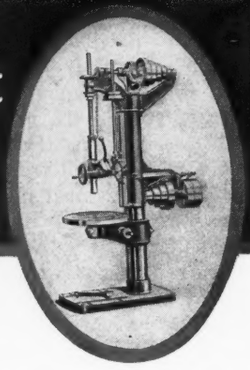
AMERICAN FOUNDRYMEN'S MEETING

At a meeting of the board of directors of the American Foundrymen's Association, 140 S. Dearborn St., Chicago, Ill., held in New York in November, it was decided to hold the next convention of the association and exhibit of foundry equipment in the fall of 1924, preferably in the month of October. It was formerly the practice of the association to hold its annual meeting in the fall, but owing to business conditions in 1921 it was decided to postpone the meeting until the spring of 1922. In 1923 the meeting was also held in the spring, but it is now considered advisable to return to the former custom of holding the meeting in the fall. The meeting will probably be held in some city in the Middle Western states.



Fifty Years Development in Drilling Machines



A Comparison between Early and Present-day Designs of Upright and Radial Drilling Machines

IT is fifty years since Henry Bickford, early in 1874, began to build, as a specialty, five sizes of upright drills in a small shop at Front and Pike Sts., Cincinnati, Ohio. From this small beginning has developed what is now The Cincinnati Bickford Tool Co. The history of this concern for the last fifty years is closely identified with drilling machine design during that period, and a study of the gradual development that has taken place in the construction of drilling machines can be made by simply following the designs brought out by this concern in the last half century.

The Upright Drilling Machine of Fifty Years Ago

The first machine designed by Mr. Bickford, who was a native of New Hampshire and who, previous to going into business for himself, was employed by the J. A. Fay & Co., Cincinnati, was built in five sizes and in capacities ranging from 20 to 38 inches. This machine is shown in Fig. 1. In one of the early catalogues these machines are described in the following words: "They have patent quick-return feed; acknowledged the best used. Spindles are steel, counterbalanced by weight inside of column. All gears, including back-gear and pinion, are cut from the solid. The tables are adjusted to height by rack and pinion, turn in the arm, and swing around the column. They have steel forgings, are gotten up with care, are true and perfect, very heavy, strong and convenient, guaranteed first-class in every respect. The journals are lined with the best anti-friction babbitt metal, and the drill spindle cannot drop when the point of the drill works its way through the iron." Three thousand of these machines were built previous to 1885.

Development of Upright Drilling Machines

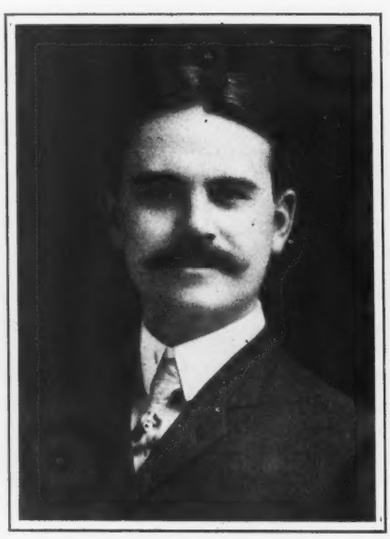
In order to illustrate the development that has taken place in upright drilling machines during the last fifty years, let us take as an example a 24-inch machine. In the early models built by Mr. Bickford, we find that there were only two feeds. The corresponding machine today has six feeds. The feed range in the early machine was from 0.005 to 0.007 inch per revolution, while today it is from 0.006 to 0.039 inch. The early machine had four speeds. This was increased in 1903 to eight speeds, and at present these machines are provided with sixteen speeds. The range of speeds in the early machines was from 54 to 296 revolutions per minute, while this range is now from 38 to 534 revolutions per minute.

The increase of power in modern machines is even greater. The horsepower of the belt at minimum speed in the early 24-inch upright drilling machine was less than 1½; in 1903 we find this increased to nearly 3 horsepower, and in 1923 to over 9 horsepower. At maximum speed the horsepower of the early machine was less than 3½, while today it is over 9. At the same time the weight of the machine has been increased from 1500 pounds in the early machine, to 1825 pounds in 1903, and to 2200 pounds in 1923.

Development of Radial Drilling Machines

In 1887, the business, patterns, and patent rights of Mr. Bickford were acquired by the Bickford Drill Co., which was formed with a view to increasing the facilities of the business by adding new machines to the line. The first addition consisted of 3- and 4-foot plain radial drilling machines, and a 4-foot universal radial machine in which the head could be set at an angle. The first machines of this type had the appearance shown in Fig. 2. As will be noted, they were of the round-column type, and the driving cone and back-gears were supported from the base. The spindle of the universal machine was advanced and returned by means of a screw, while the spindle of the plain machine was operated by a rack and pinion. The arms were raised

Henry Bickford, who began to build Upright Drilling Machines in Cincinnati in 1874



Harry C. Hoefinghoff, President of the Bickford Drill & Tool Co. 1898-1907

A. H. Tuechter, President of the Cincinnati Bickford Tool Co. since 1909

and lowered by power, the heads were traversed by screws, and each spindle had three changes of power feed and eight changes of speed. The three-foot radial machine had a 10-inch column and weighed 4200 pounds, while the four-foot radial had an 11-inch column and weighed 5400 pounds.

The only other radial drill built in Cincinnati at that time was made by the Universal Radial Drill Co., founded in 1882 or 1883.* The arm lengths of this company's universal radial drills were 5 and 6 feet, with a "center-of-circle" capacity of 8 and 10 feet, respectively. The company also made plain machines with arm lengths of 4, 5, 6, and 8 feet. The chief characteristics of these machines were the drive and the column. The countershaft consisted of "a frame with horizontal shaft and tight and loose pulleys and a pair of cut miter gears." A shaft eight feet long was furnished "to allow for the difference in height of ceiling, with keyseat whole length to connect from countershaft to driving wheel on top of column," which, it was claimed "will accommodate any ceiling to 15 feet in height."

The driving wheel referred to transmitted the power to a spur gear keyed to a vertical shaft in front of the column, whence the power passed through miters to a four-step cone carried in a frame mounted on the girdle of the arm and thence to a second cone, equipped with back-gears, which drove the arm shaft. The column sleeve extended to the base and was "fitted over a stationary stump, bolted fast to the sole plate. This stump," the catalogue continues, "has sufficient length of bearing to prevent column from swaying, and is provided with an adjustable pivot bearing upon an elastic diaphragm in the column, which, when the bolts in flange at the lower end of column are slackened, takes the weight of the machine off the flange bearing, and allows the column, with arm, etc., to revolve easily the entire circle."

In 1884 this machine received the highest award at the Twelfth Cincinnati Industrial Exposition. In 1886 the business passed into the hands of P. G. March of Cincinnati, Ohio, who, in 1894, sold it to the Bickford Drill & Tool Co.

Comparison Between Early and Present Radial Drills

Taking a 6-foot plain radial drilling machine as an example, we find that the width of face of the arm has been

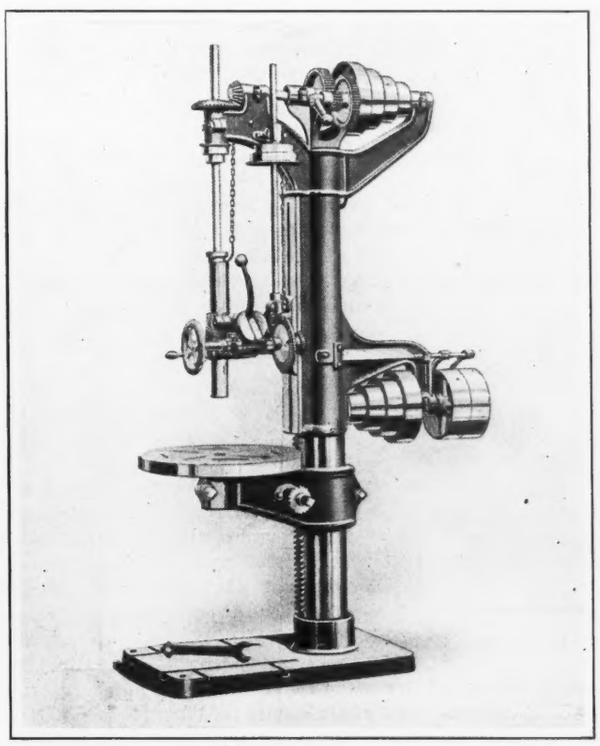


Fig. 1. Upright Drilling Machine designed and built by Henry Bickford Fifty Years ago

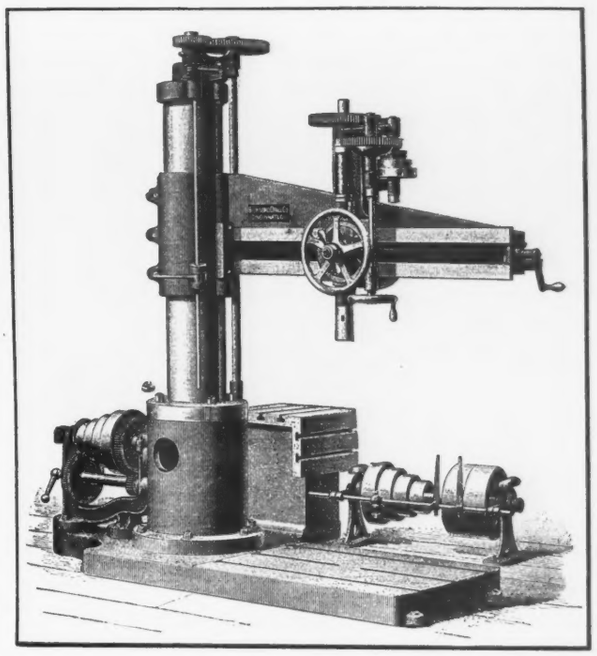


Fig. 2. Radial Drilling Machine designed and built by the Bickford Drill Co. in 1887

increased from 8 inches, in 1884, to 15 inches in 1923; the width of the driving belt, from 2½ inches to 3½ inches; the diameter of the column, from 10 to 15 inches; the speed of the countershaft from 180 to 525 revolutions per minute; the size of the tight and loose pulleys, from 12 by 3½ inches to 16 by 4¾ inches; the spindle diameter, from 1 15/16 to 2 7/16 inches; the vertical range of the spindle, from 15 to 19 inches; and the number of speed changes, from 8 to 32. The range of speed in the 1884 machine was from 7 to 247 revolutions per minute, while the same range in the 1923 machine is from 20 to 544 revolutions per minute. The number of feeds has been increased from 3 to 5, and the feed range which, in 1884, was from 0.006 to 0.010 inch, is now from 0.006 to 0.024 inch.

The most remarkable development in radial drilling machines, however, is to be found in their power and weight. The horsepower at minimum speed in the 1884 machine was only 1.17. Ten years later we find this increased to 2.18 horsepower; thirty years later—in 1914—to 12 horsepower; while in 1923 the machine is capable of absorbing 25 horsepower. In 1884, the horsepower at maximum speed was 2.5, while in the present-day design, it is 25. The weight of the 1884 type machine was only 3800 pounds. In 1894 this had been increased to 11,000 pounds, and in 1923 the same machine weighs 16,000 pounds.

It may also be of interest to note how this development has affected the possibilities for high-speed drilling. Records are not available further back than 1901, but at that time a test block, in the form of a cast-iron plate 1 inch thick, was drilled with fifteen holes ranging from ½ inch to 3½ inches in diameter. The holes in this plate were drilled at that time in 26 minutes 53 seconds, including all changes of drills and speeds. At the present time, this test block can be drilled in 12 minutes 34 seconds, or in less than half the time, in a size smaller machine.

Brief History of the Development of the Cincinnati Bickford Tool Co.

In 1893 the Bickford Drill Co., which had been founded in 1887, was reorganized under the name of the Bickford Drill & Tool Co., with Charles Hoefinghoff as president; August Herman Tuechter, general manager; and Anton Mill, engineer and superintendent. Mr. Tuechter had been associated with Mr. Hoefinghoff in various capacities since 1885; while Mr. Mill, a graduate of the University of Koenigsberg, Germany, had been in the United States but a few years

and had formerly been employed as a designer by the Cincinnati Milling Machine Co.

Mr. Mill designed the line of plain radial drills with a "center-of-circle" capacity of 5 feet 9 inches, 7 feet 2 inches, 9 feet, and 11 feet; and also a 5- and 5½-foot half universal, and a 4½- and 5½-foot full universal radial drill. He equipped the smallest of the plain machines with a swinging or swiveling table, placed the back-gears on the head, graduated the spindle sleeve for reading depths, and provided an automatic trip for the spindle. On the larger sizes of plain radials, he replaced the head-moving screw with a rack and pinion, incorporated an automatic reversing mechanism, and added an auxiliary ring to assist in binding the sleeve to the column. His changes in the universal radials consisted, mainly, in substituting a rack and pinion for the former screw feed, to admit of the spindles being advanced or returned as quickly as the spindle in a plain tool.

Mr. Mill remained with the Bickford Drill & Tool Co. until 1897, when Henry McCoy Norris became superintendent and engineer. Mr. Norris served an apprenticeship with Bement, Miles & Co., Philadelphia, Pa., after which he took a special course in mechanical engineering at Sibley College, Cornell University. He has been employed by several machine tool builders, among which may be mentioned the Brown & Sharpe Mfg. Co., the Pond Machine Tool Co., and the Garvin Machine Co. The most noteworthy features incorporated in radial drilling machine design by Mr. Norris are: An arm made in pipe section, and one that lowers at double its elevating speed and is provided with means to guard against being set in motion by accident; an automatic trip which permits full spindle travel while serving as a safety stop; a back-gear that furnishes four changes of speed; a depth gage that reads from zero; a geared feed-box which gives instantly eight changes of feed; and a speed-box which, with the back-gears, furnishes 16, 20 or 24 changes of spindle speeds.

Upon the death of Mr. Hoefinghoff in 1898, Mr. Tuechter entered into partnership with S. C. Schauer, who for the previous eight years had been superintendent of the Hamilton Machine Tool Co., Hamilton, Ohio. They formed the Cincinnati Machine Tool Co. and specialized in upright drilling machines, while the Bickford Drill & Tool Co. at that time concentrated on the manufacture of radial drills. Mr. Schauer provided friction back-gears, a positive geared feed-box, a geared tapping attachment and worm-wheel elevating mechanism on his machines. He also brought out the modern high-speed shaft-driven upright machine.

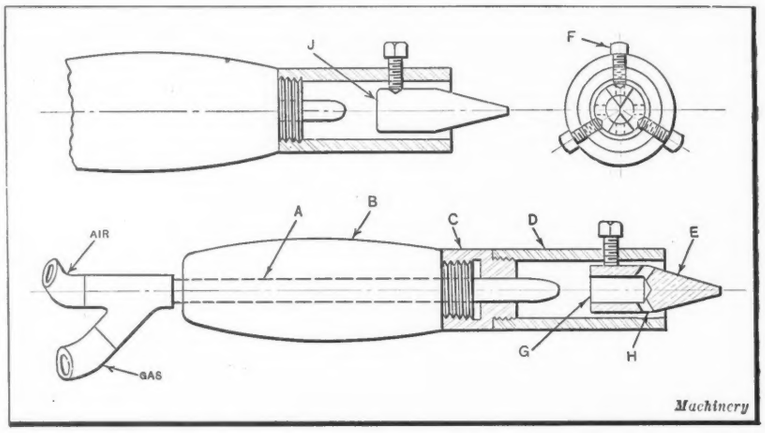
During this period, Harry Conrad Hoefinghoff was president of the Bickford Drill & Tool Co. until his death in 1907. In 1909 this company and the Cincinnati Machine Tool Co. were consolidated under the name of the Cincinnati Bickford Tool Co., with A. H. Tuechter as president. The new plant of this company at Oakley, Ohio, just outside of Cincinnati, was completed early in 1911. The types of machines brought out by the company since that date are well known to the readers of MACHINERY, as all of these developments have been recorded. The records of the various companies that now form the Cincinnati Bickford Tool Co. show that since 1874 they have built 15,000 upright drilling machines and over 10,000 radial machines.

* * *

GAS-HEATED SOLDERING IRON

By ARTHUR PONELEIT

A gas-heated soldering iron which has proved very satisfactory for general soldering in repair shops is shown in the lower view of the accompanying illustration. The part *A* is a ⅛-inch iron pipe which serves as the gas blower or torch. This pipe is provided with an inlet for gas and air as shown. After *B* and *C* are assembled together, part *A* is forced through parts *B* and *C*. The bushing *C* is brazed to part *A*, and the tube *D* is screwed on the threaded portion of part *C*.



Gas-heated Soldering Iron

The soldering iron *E* is made from a piece of round copper bar, the end of which is formed or pointed to the desired shape. The three set-screws *F* are employed to center and hold the iron in place. It was found that more uniform heating of the iron point with a lower consumption of fuel was obtained with the iron shown at *E* than was possible with the solid type of iron shown in the upper view at *J*. The improved iron shown at *E* has a large hole drilled at *G* and several smaller holes at *H*.

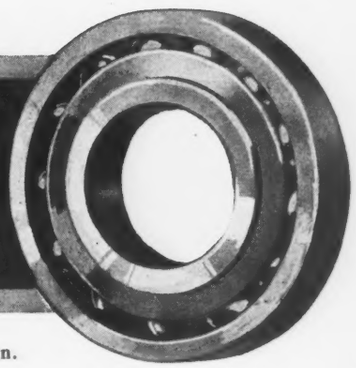
* * *

Standardization engineering is now a recognized profession in Germany, and the rapid development of standardization work has created a demand for men experienced in standardization procedure. Advertisements for standardization engineers and for people to do standardization work regularly appear in the engineering press. An interesting development in the last few years is the appearance of consulting engineering firms specializing in standardization work. There are now five such firms in Germany. This work is closely connected with industrial or efficiency engineering, in which there is now great and growing interest. The largest of these firms devotes about half its time to standardization work, employing a staff of over forty. It has as clients trade associations as well as individual firms, the latter including both large and small companies. One of its clients is the trade association representing the automobile industry. In this work many of the services are performed that would be done by an ordinary headquarters standardization staff.

GREAT STRENGTH
is one of our leading points on our tools. Write to us for anything in the line of Drilling Machinery. : :
Bickford Drill & Tool Co.
535 East Front Street,
Cincinnati, Ohio.

Fig. 3. First Advertisement of the Bickford Drill & Tool Co. in MACHINERY, May, 1896

Application of Ball Bearings to Machine Tools



By B. M. W. HANSON, President, The Hanson-Whitney Machine Co., Hartford, Conn.

THE use of anti-friction bearings has been so widely discussed during the last thirty years that it may seem impossible to write anything more of interest on the subject. It is a fact, however, that the number of anti-friction bearings employed in machine tools and power transmission systems has not increased so rapidly as it should, considering the proven superiority of the different types of ball and roller bearings for various kinds of service. This is rather astonishing in view of the great number and variety of high-grade machines built every year by machine tool manufacturers.

The chief reason for the slow adoption of ball bearings by machine tool builders may have been the high initial cost, but the writer doubts very much if good anti-friction bearings are as expensive in the long run as the plain type of bearing so commonly employed. It has been the writer's experience that ball bearings, when properly applied to machine tools, have great durability and will cause little if any trouble even when they are subjected to constant and severe use. On the other hand, the old-time solid bearing that roughs up or becomes overheated may cause the manufacturer considerable trouble. In some cases, it may be necessary for him to send a repair man hundreds of miles to remedy the trouble caused by overheated bearings, and the cost of such a trip may be a great deal more than the difference between the cost of a ball bearing and that of the bushing type of bearing, not considering the annoyance to the customer and the unfavorable impression that such an incident creates.

The speeds that are now used in gear-boxes and various transmissions on machine tools are so high that when plain bearings are used, considerable trouble is likely to be encountered. The writer believes that ball bearings offer the best method of eliminating this difficulty. The principal ball bearing manufacturers in this country and abroad have reached such a stage in the development of their product and they have such competent staffs of engineers from whom the manufacturers of machine tools can obtain advice that the problem of the proper application of ball bearings should not be a hard one.

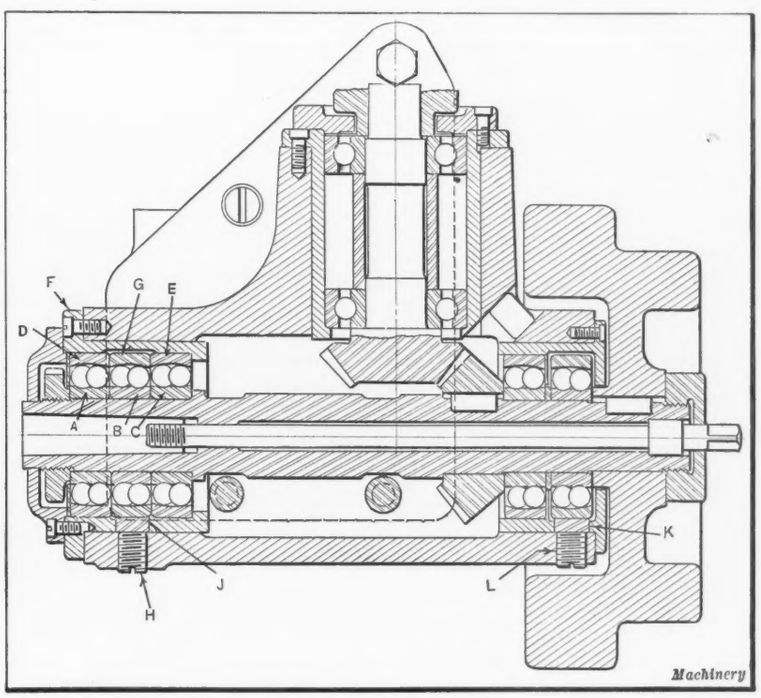


Fig. 1. Ball Bearing Spindle of Thread Milling Machine

The writer does not mean to say that ball bearings can be successfully applied to machine tools in all cases, but it is his belief that in most instances where they have not proved as satisfactory as expected, the trouble has been due to the fact that the correct size of proper mounting was not used. When a pulley fails to drive a certain machine, we do not decide that all pulleys are useless, but instead we try out new pulleys until one is found that is suited for the work to be done. Also when a gear breaks, we do not condemn gearing as a whole, but select a new gear having sufficient strength to meet the stresses imposed upon it. However, many designers are likely to think that ball bearings are not satisfactory for a certain purpose merely because they have tried out one size or type of bearing and found that it would not stand up. Thus in many cases the use of ball bearings is condemned as impractical, when the application of a larger or properly designed ball bearing would give satisfactory results.

It is a question whether ball bearings are superior in all cases to the different types of roller bearings now on the market. Roller bearings have proved very satisfactory when properly employed on certain types of machine tools, and it would be worth while to investigate both types of bearings as to their adaptability for any particular purpose before rejecting anti-friction bearings as being unsatisfactory. The writer has had little experience with roller bearings, but he has been very successful in the application of ball bearings to various types of machine tools of his own design.

Machine tool manufacturers, as a whole, have been very conservative in the use of anti-friction bearings for the main spindles of machine tools. For instance, very few attempts have been made to employ ball bearings for the main spindles of lathes, milling machines, or grinders. Experiments made during the last three years have proved that ball bearings are satisfactory for certain classes of milling and grinding machine spindles, and also for heavy-duty turning lathes. It has been said frequently that it is impossible to make a spindle run absolutely true in ball bearings. This, however, is a very

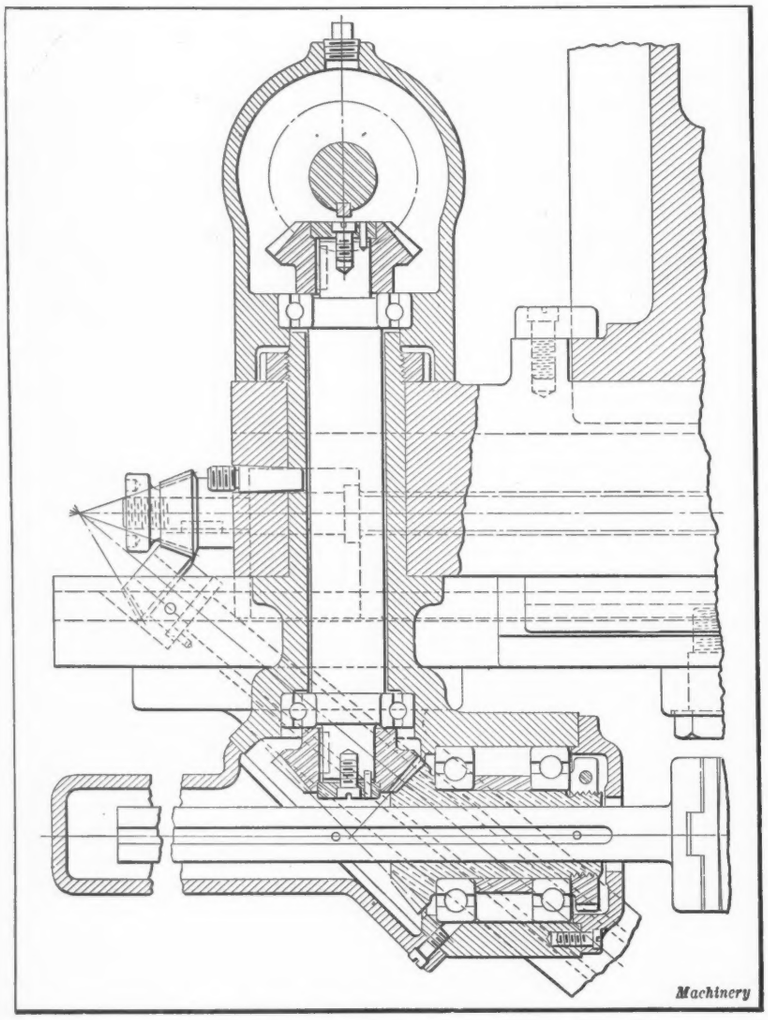


Fig. 2. Bevel Gear Drive that connects with the Spindle shown in Fig. 1

sweeping statement. Experiments have been made with carefully constructed ball bearing spindles that serve to disprove the truth of this statement.

Thread Milling Machine Spindle Equipped with Ball Bearings

In Fig. 1 is shown a thread milling machine head equipped with a ball bearing spindle which is sometimes run at speeds as high as 2500 revolutions per minute. A good many of these milling heads have been in use for a long time and have never given any trouble. The front bearing housing carries three bearings side by side, the inner rings *A*, *B*, and *C* being mounted solidly on the spindle. The outer rings *D* and *E* are snugly fitted in the housing *F*, but the middle outer ring *G* has no bearing at all in the housing. In front of the set-screw *H* is a shoe *J* which makes a 30-degree arc of contact with the outer periphery on the ring *G*. This shoe is pressed against the ball bearing so that it insures absolute contact between the inner and outer rings. The pressure exerted by the shoe acts in the same direction as the pressure caused by the contact of the cutters with the work.

In this particular cutter-head, there are two ball bearings in the rear housing, one being a tight fit in the bore of the housing, and the other provided with a clearance on all sides of the outer ring except at the under side, where a shoe *K* is forced into contact with it by the set-screw *L*. This shoe and set-screw are not generally necessary unless great accuracy is required. Several different styles or makes of ball bearings may be used for this particular purpose. The well-known S K F bearing is shown in the illustration, but a deep-groove bearing like the Hess-Bright type can be used. The latter type is, perhaps, preferable when a heavy end thrust is encountered. The particular arrangement of the bearing illustrated is a development of the S K F Co. and is especially adapted for main spindles of milling machines and grinding machines. The writer believes that it would also be an ideal bearing for a lathe. In fact, experiments now being made indicate that very fine results may be expected from lathe spindles equipped with this kind of bearing.

Ball Bearing Bevel Gear Transmission

The bevel gears shown in Fig. 2 are mounted on shafts that run in ball bearings. The outside diameter of the gears is 2⅞ inches, and the speed 1000 revolutions per minute. A liberal amount of lubricating oil is supplied to the gears and bearings constantly. This mechanism leads up to and drives the milling cutter head shown in Fig. 1. The machines on which this type of bearing has been employed have been in operation for several years, and no trouble of any kind has been experienced with either the bearings or gears. When a cut is not being taken, the driving power of a belt made from an ordinary shoestring is sufficient to revolve the whole mechanism at a speed of 1000 revolutions per minute.

In Fig. 3 is shown the driving and driven shafts of a power transmitting unit of a machine tool. The unit is so arranged that the driving shaft *A* can slide in the driving gear *B* which is mounted on ball bearings. The driven gear *C* is keyed to the driven shaft *D*, which is also mounted on ball bearings, one of which is shown at *E*. The illustration shows quite clearly that the thrust on the bevel gears has been carefully considered in designing the mounting of the bearings.

Ball Bearing Vertical Milling Machine

A vertical milling machine spindle equipped with ball bearings is shown in Fig. 5. The spindle *A* runs in its independent bearings *B*, *C*, and *D*, while the pulley *E* that drives the spindle runs on separate and independent bearings *F* and *G*, so that the pull or strain of the belt does not affect the spindle bearings. A similar construction has

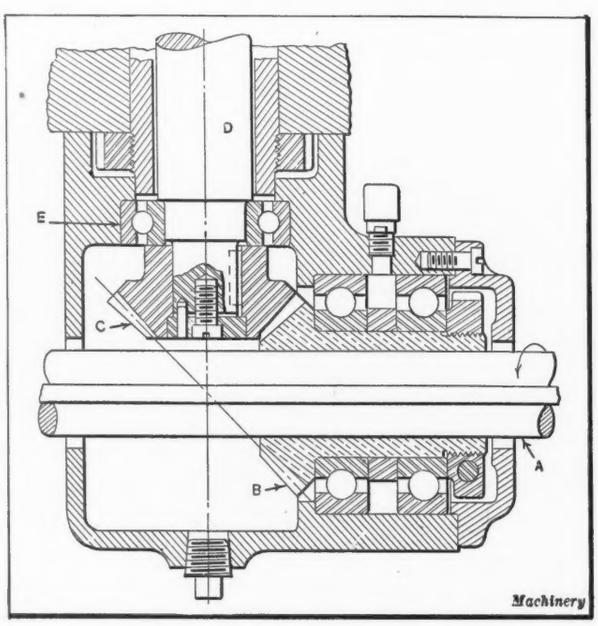


Fig. 3. Ball Bearing Bevel Gear Drive

been employed successfully for many years on the spindle drive of a vertical surface grinding machine. The ring *H* is fastened to the frame *J* of the machine, and contains several springs *K* which serve to hold the ball bearing *D* in place. The washer *L* is provided to relieve the ball bearings from any strain or shock that might result from driving a tapered shank in or out of the taper collet *M*.

Cutter-head Equipped with Ball Bearings

The spindle of the cutter-head shown in Fig. 4 is mounted on four ball bearings. Three of the bearings are located in the housing at the cutter-end of the spindle, and the fourth in the housing at the outer end of the spindle. It will be noted that the driving pulley *A* is located between the two bearing housings. The provisions for retaining the lubricant in the bearing housings and for excluding dirt or dust from the bearings are clearly shown in the illustration. Pressure is applied to the outer race *C* of the middle ball bearing by means of screw *B*, the same as in the case of the thread milling machine shown in Fig. 1. Care is taken to have this screw so positioned that the pressure exerted on the ball bearing will act in approximately the same direction as the load on the cutter.

Ball Bearing Grinder Spindles

In the upper view of Fig. 6 is shown a high-speed grinder spindle of the type employed by a large number of manufacturers. While good results are obtained with spindles of this design, tests made by some of the large machine tool buiders have shown that even better results are obtained with the improved type of grinder spindle shown in the lower view. Although the latter spindle has been employed successfully on a 12-inch precision grinder, the same general design is well adapted for use on smaller high-speed grinders. It will be noted that the middle ball bearing in the housing at the head end of the spindle is provided with a pressure-adjusting screw *B*, similar to the milling machine spindles.

Drill Spindle Mounting for Ball Bearings

The drill spindle mounting shown in Fig. 7 has two radial ball bearings *A* and *B* and a ball thrust bearing *C*. When nut *D* is tightened, collar *E*, the inner races of bearings *A* and *B*, the hub of the driving gear at *F*, and washer *G* are clamped together against the shoulder at *H* on the drill spindle. The outer race of bearing *B* is supported by washer

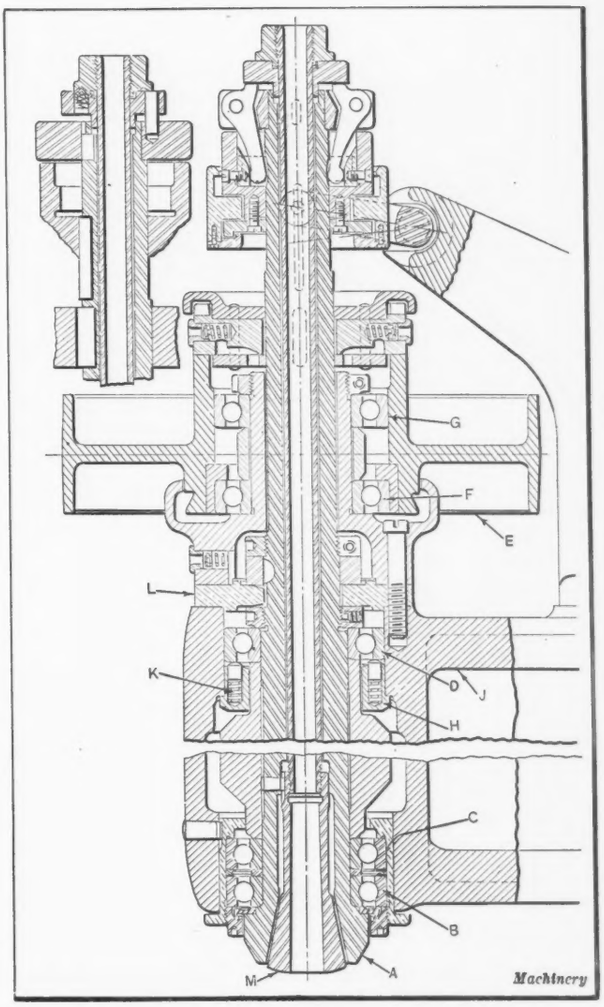


Fig. 5. Vertical Milling Machine Spindle mounted on Ball Bearings

J, which is backed up by six springs *K* having a total compression of 510 pounds. The upper race of thrust bearing *C* is also backed up by six springs *L* which have a total compression of 425 pounds. The difference of 85 pounds between the compression of springs *L* and *K* is compensated for by the weight of the drill spindle, its driving gear, and equipment. Sufficient clearance is provided at *M* and *N* to allow the action of springs *K* and *L* to take up any play that may result from wear or any expansion caused by the heating of the spindle.

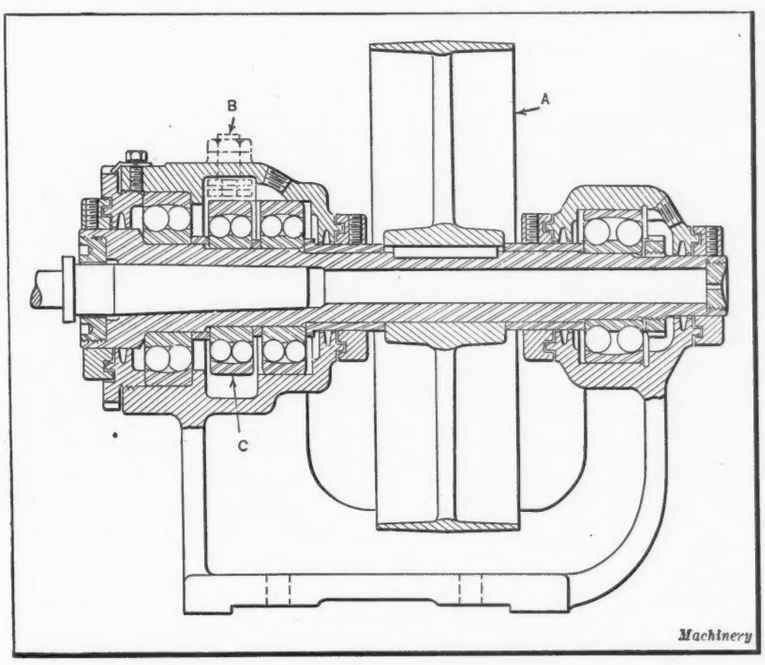


Fig. 4. Cutter-head provided with Ball Bearing Spindle

Drilling Machine Gear Drive Equipped with Ball Bearings

A ball bearing gear drive for the cone pulley of a drilling machine is shown in Fig. 8. Seven ball bearings are incorporated in the complete drive, as shown in the illustration. The loose pulley *A* runs on ball bearings *B* and *C*. The driving shaft *D* on which the bevel driving gear *E* is mounted runs in the bearings *F* and *G*. Shaft *H*, which drives the cone pulley *J*, is located at right angles to the driving shaft and runs at a much higher speed. It will be evident that the thrust on the bevel gears is taken by the ball bearings *G* and *K*. The cone pulley *J* is mounted on the self-aligning bearings *M* and *N*.

Ball Bearings Applied to Polishing Lathe Spindle

Polishing lathe spindles ordinarily run at very high speeds, and consequently considerable care is required to keep them properly

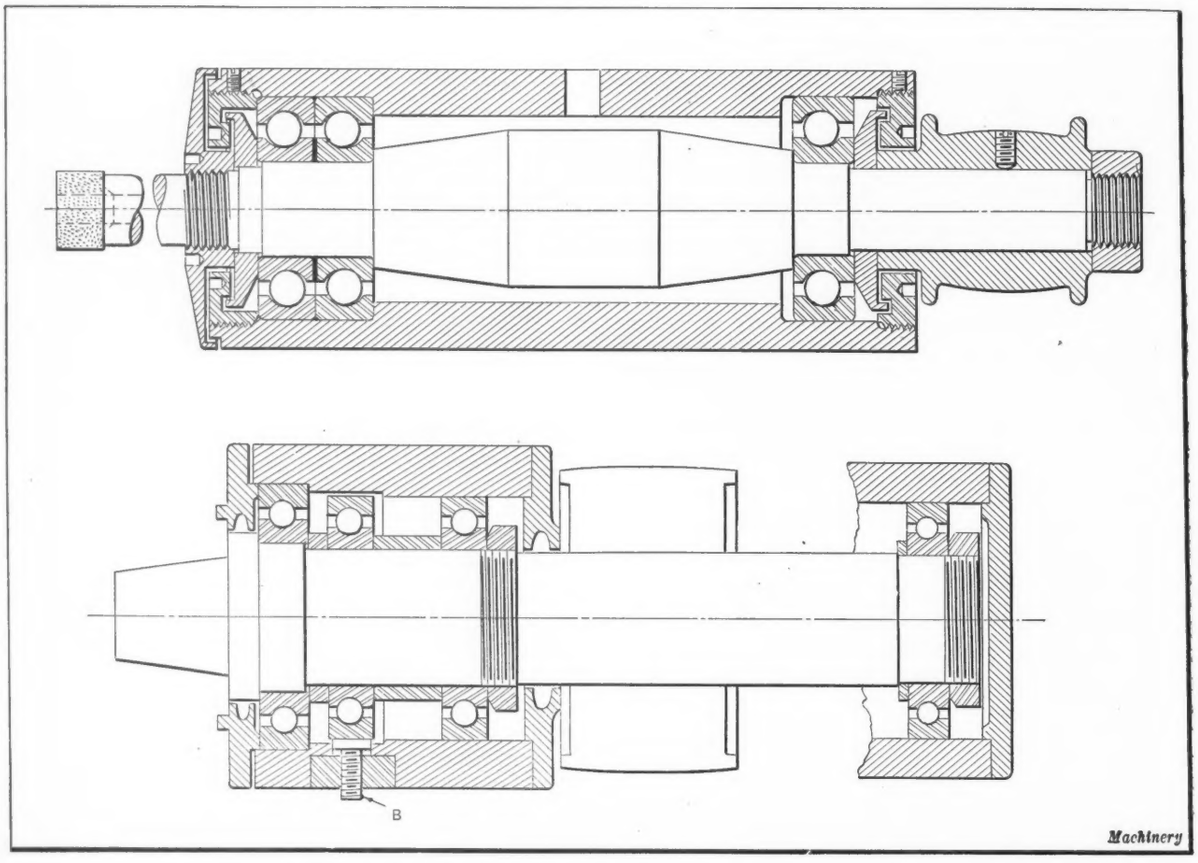


Fig. 6. Two Designs of Ball Bearing Spindles Applicable to High-speed Grinders

lubricated when plain bearings are used. Spindles equipped with ball bearings can, of course, be run at much higher speeds than those equipped with plain bearings. Another advantage of the ball bearing spindle is that it requires oiling less frequently. In Fig. 9 is shown a polishing lathe spindle equipped with self-aligning ball bearings and a ball bearing loose pulley. The illustration shows the details of construction quite clearly and should need no explanation.

Equipping Lathe Spindles with Ball Bearings

A ball bearing mounting that has proved satisfactory for a lathe spindle is shown in Fig. 10. It will be noted that two bearings *A* and *B* of the deep-groove type are employed to support the front end of the spindle. A double-row self-aligning type of ball bearing *C* supports the rear end. The ring *D* is carefully fitted by scraping during the assembling operation, so that when the inner races are clamped together, end play will be eliminated without exerting undue pressure on the bearings which would cause an initial thrust load. Bearings *A* and *B* are heated in oil to a temperature of 175 degrees F. in order to facilitate assembling them on the spindle.

In Fig. 11 is shown a lathe spindle designed for operation at high speeds. All the bearing housings are bored at one time to insure accurate alignment of the ball bearings. The lathe spindles shown in Figs. 10 and 11 have both proved satisfactory, and the writer believes that the time will come when ball bearings will be regularly employed by the leading manufacturers of machine tools for the main spindles of lathes and milling machines.

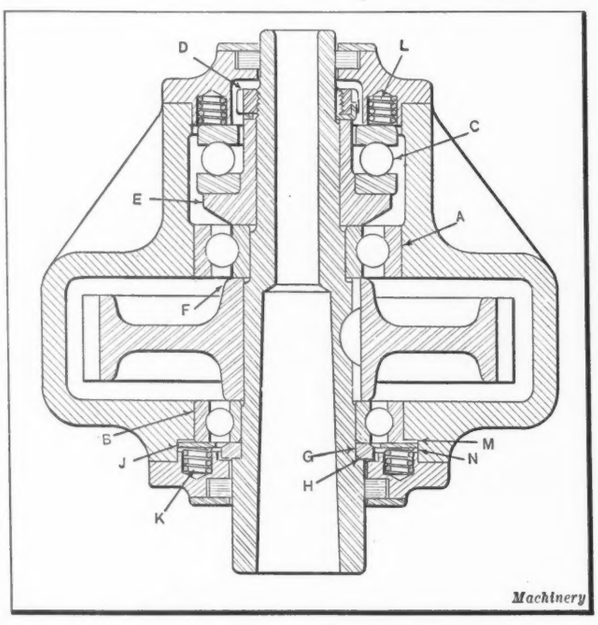


Fig. 7. Drill Spindle equipped with Ball Bearings

Ball Bearing Lathe Centers

In Fig. 12 is shown a revolving center for a lathe tailstock which is provided with ball bearings of the deep-groove type. In this design the thrust is taken by the same bearings that support the lathe center. The retaining cap *A* is fitted with packing at *B*, which makes the housing practically oil-tight. Thus sufficient oil can be placed in the housing to insure good lubrication of the bearings for a considerable period of time.

Another design of revolving tailstock center is shown in Fig. 13. This design also has a body or housing which is oil-tight. The ball bearing at the front end of the center is of the self-aligning type, while the one at the rear is of the deep-groove design. The thrust on the center is taken by a third ball bearing located at the extreme rear end of the center. This ball bearing is especially designed to take thrust loads.

End Thrust on Ball Bearing Spindles

There has been considerable controversy regarding bearings having a heavy end thrust. It is advocated by

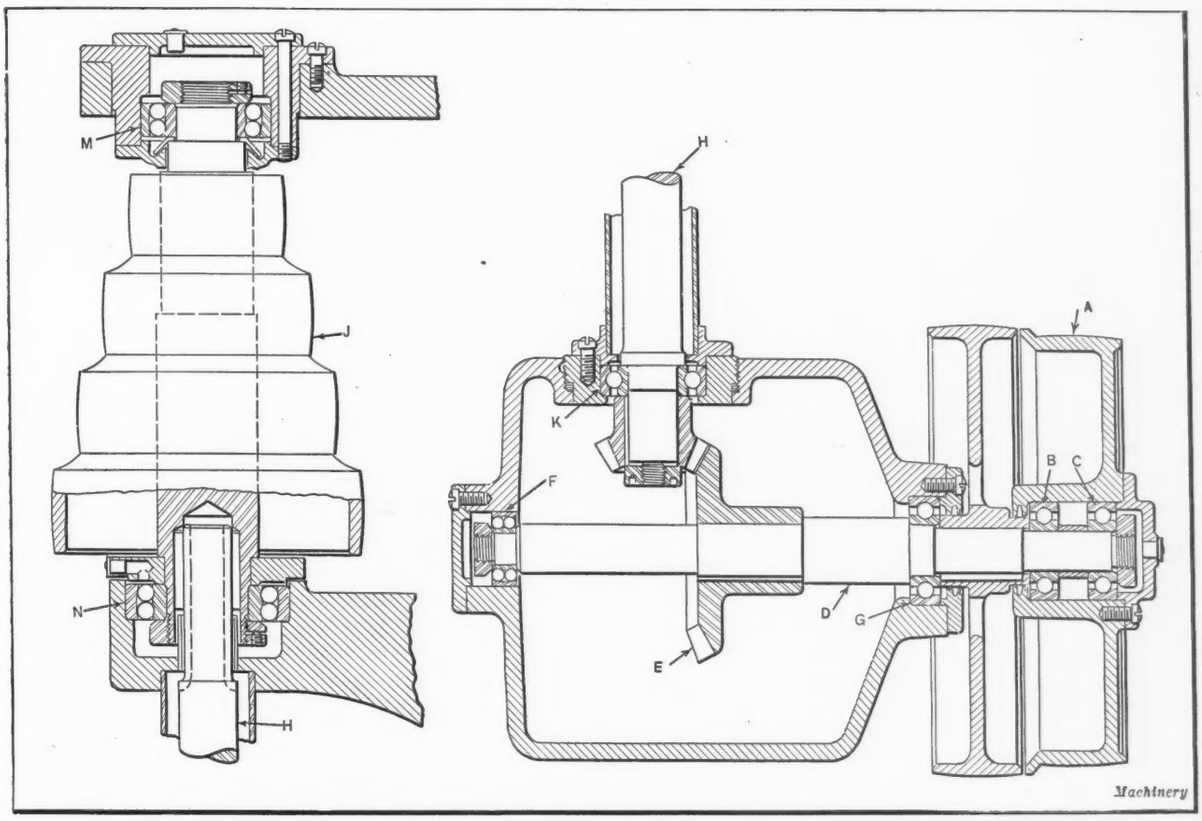


Fig. 8. Drilling Machine Drive equipped with Ball Bearings

some designers that a deep-groove bearing be used, such as the Conrad patent bearing. This bearing is designed so that it will take 100 per cent of the load when it is applied in either direction. However, in some cases it has been found preferable to employ an independent thrust bearing. There is no doubt that there are cases in which each design has its special merits, and no one rule can be given that will cover the proper application in every case. Undoubtedly both kinds of bearings will always be needed to meet all the requirements of the machine tool designer.

It is generally preferable to locate the bearing that takes the end thrust as close to the point at which the thrust is applied as possible, so that the expansion and contraction caused by variations in temperature and other conditions will affect the position of the cutter or work as little as possible. For the front bearing of a machine spindle the three-bearing system has the advantage that it takes up the end thrust within a very short length of the spindle. Bearings that are mounted far apart on a spindle that is subject to considerable change in temperature are almost certain to give trouble. Also, where there is a deflection of the spindle, the bearings should be mounted in such a way as to make them self-aligning, unless they are of a type in which the self-aligning feature is incorporated in the bearing itself, as is the case with the S K F self-aligning type of bearing.

The drilling machine was probably the first machine tool in which ball bearings were used. At first ball bearings were employed only for taking the end thrust of the spindle. Today practically all manufacturers equip their drilling machine spindles with ball thrust bearings. The writer believes that it would be the best practice to employ ball

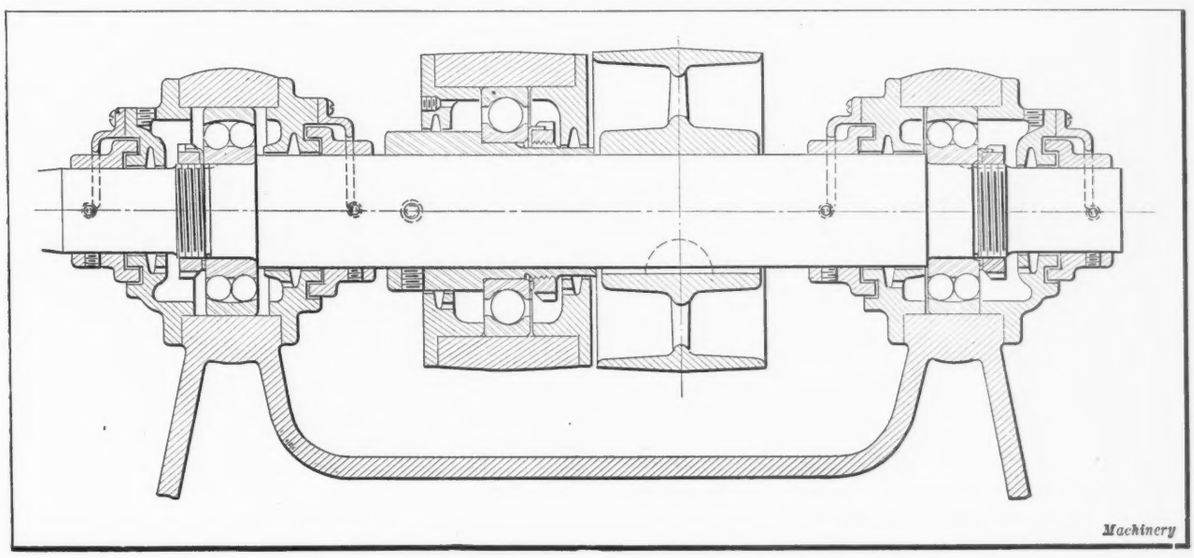


Fig. 9. Polishing Lathe Spindle mounted on Self-aligning Ball Bearings

bearings of sufficient size to take the end thrust, and at the same time serve as a regular bearing for the spindle.

Considerable progress is being made in the use of ball bearings for high-speed milling machine spindles. Ball bearings are now universally employed in such machines as die-sinkers and profilers, and it is probably only a question of time when all the larger machines will be fully equipped with ball bearings. The manufacturers have not yet adopted ball bearings for the spindles of large-diameter grinding wheels, and to the writer's knowledge no real effort has been made to employ them for this purpose.

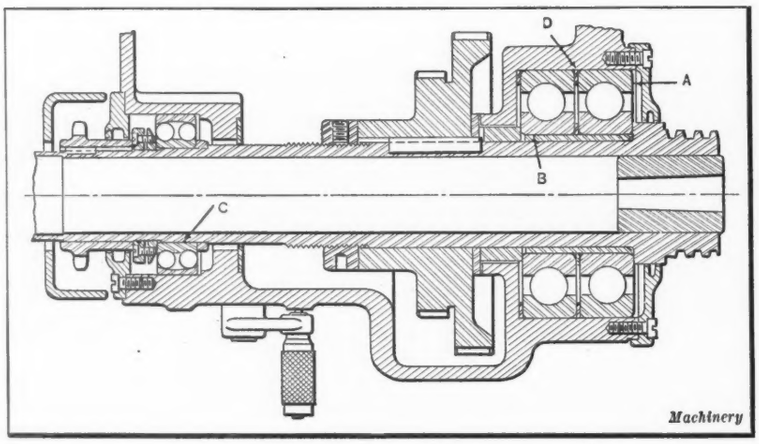


Fig. 10. Ball Bearing Lathe Spindle

Recently the writer designed and made experiments with a grinding machine having a ball bearing spindle on which 12-inch grinding wheels were employed. As this machine has only been in use for a short time, it is not possible to say what the ultimate result will be, although excellent results have been obtained so far. No difference between the finish obtained with this grinding machine and machines equipped with the regular type of solid bearing can be detected. There seems to be no reason why the ball bearings used in this case should not stand up well, as the speed of the spindle is not so great as that of other machines that have given excellent service when equipped with the same type of bearing.

Lineshafts and Countershafts Equipped with Ball Bearings

There are still a great many machine shops in which the old-style bearings are used for lineshafts and countershafts. Practically none of the manufacturers at present provide the countershaft equipment of their machine tools with ball bearings. In the factory of the Hanson-Whitney Machine Co., Hartford, Conn., ball bearing hangers are used for the lineshafts. As a great many machines of various makes are used in this plant, a good opportunity is afforded for comparing the service obtained from the various countershaft equipments. In some instances, ball bearing countershafts have been substituted for those furnished by the maker. Experiments have determined that every one of the old-time countershafts consumes more power than any of the ball bearing lineshafts.

With the old-style countershaft it is a difficult problem to obtain proper lubrication, and the dripping of oil on the floor and on the workmen is one of the objectionable features, not to mention the disadvantage of having someone always working around the countershafts at the top of a ladder in an effort to oil the dry or overheated bearings. It is difficult to understand why a manufacturer will build a high-grade machine tool, and then connect with it a piece of "tinware" fastened to the ceiling which he calls a countershaft. Certainly a great improvement in his product as a whole would result if ball bearings were employed for this important part of machine tool equipment. The greater amount of power consumed by the solid type of bearing is another objectionable feature, especially in these days of coal shortage and high prices.

Ball Bearing Lineshaft Hangers

In Fig. 15 is shown a countershaft constructed from two lineshaft hangers made by a well-known manufacturer of ball bearings. A large number of these countershafts are now used in the plant of the Hanson-Whitney Machine Co. This countershaft equipment consists essentially of the two ball bearing lineshaft hangers, two cast arms *A*, the nuts that hold the bearing boxes, and the usual type of belt shafting lever and guide fingers. The loose-pulley is also provided with ball bearings so that it does not require oiling more than once a year, or possibly every six months. Coun-

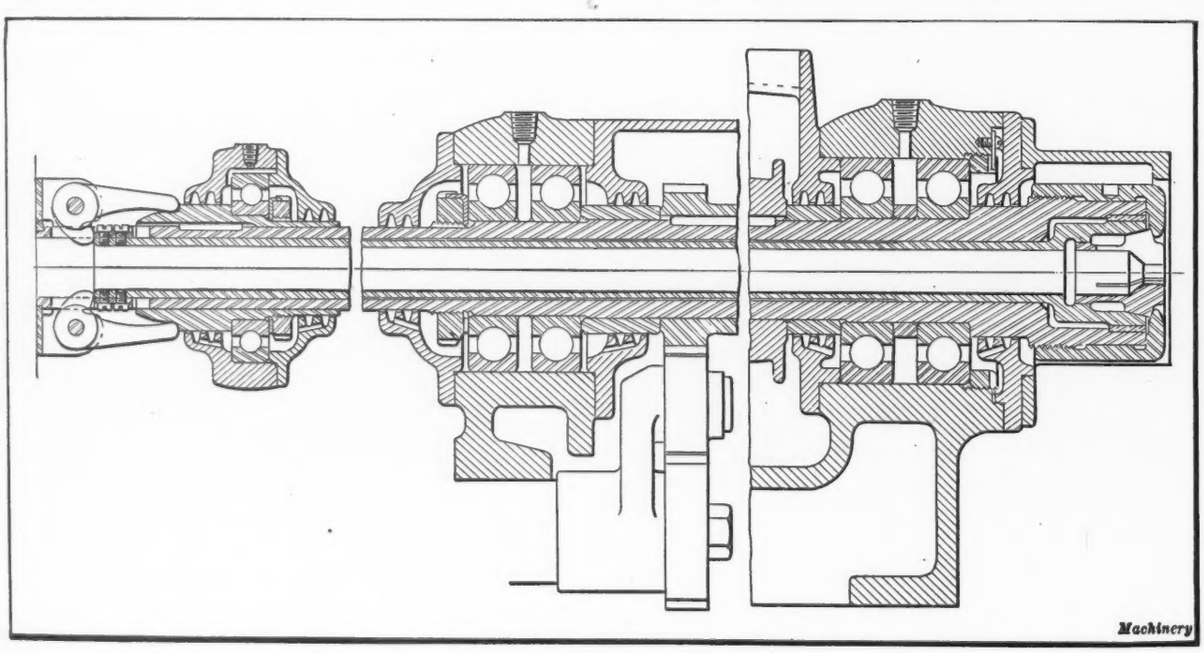


Fig. 11. High-speed Ball Bearing Lathe Spindle

tershafts of this type can be run at almost any speed, and they are quiet in operation. The equipment is light and as neat in appearance as the machine with which it is used. The ball bearing lineshaft, especially the type equipped with self-aligning bearings, is fast gaining favor in all kinds of factories, and undoubtedly will come into use more rapidly in the future on account of the high cost of fuel.

Roller Bearings for Heavy Duty

Bearings of the Conrad and the S K F style are so well known that it is not necessary to describe them here. A new development of great interest has been made in a roller bearing which is self-aligning and designed for heavy-duty purposes. This new roller bearing, which is illustrated in Fig. 14, is being used for various heavy-power transmission shafts, such as found in rolling mills and heavy electrical equipment. It is also coming into favor rapidly as a bearing for railroad cars. One or two of the railroads in the United States are now trying out this bearing on Pullman cars, and the writer understands that they have been used already for over a year with a great deal of success.

In Sweden the freight cars as well as the passenger cars of the government railroads are being equipped with this new type of roller bearing. So far the change has proved to be remarkably successful, having given an average saving

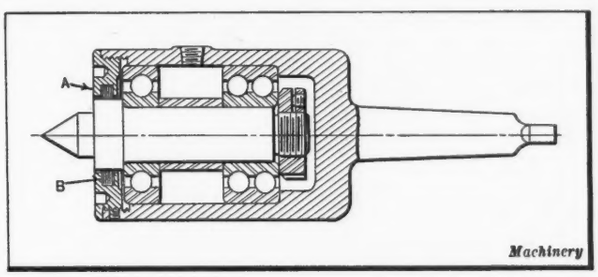


Fig. 12. Revolving Center for Lathe Tailstock

in power of about 35 per cent over the old style of solid bearing.

It will be noted that the bearing shown in Fig. 14 is composed of two rings, the general principle being the same as in the well-known S K F bearing, but instead of balls, barrel-shaped rollers are used. The contact surface of one of these rollers is equivalent to that of a ball having a much larger diameter. In other words, if balls having an equivalent contact surface were employed instead of the rollers, the

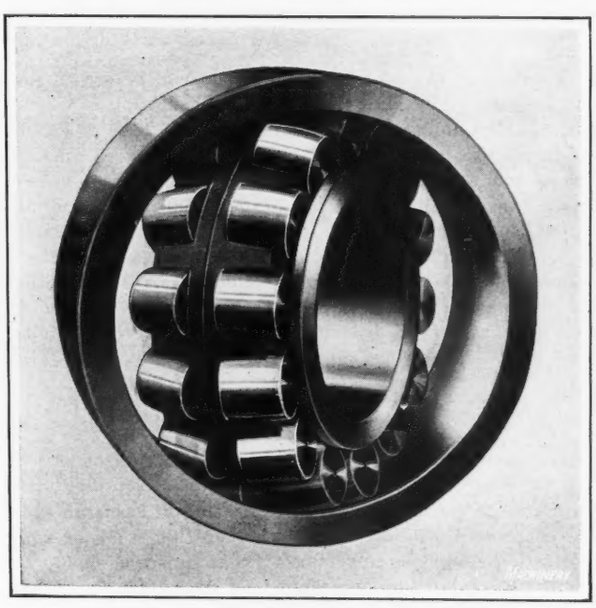


Fig. 14. Roller Bearing adapted for Heavy Duty

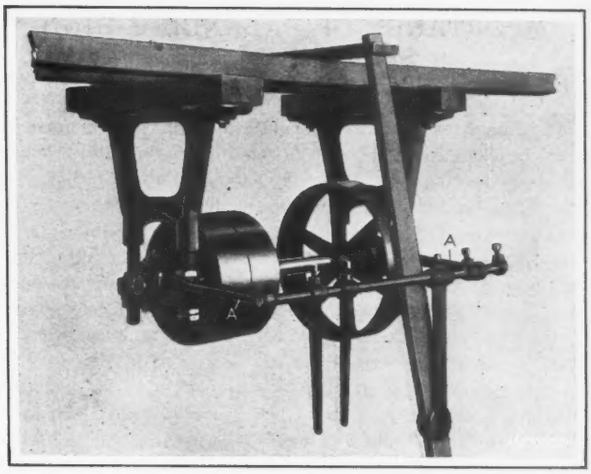


Fig. 15. Ball Bearing Countershaft

outside diameter of the bearing would be so large as to prevent its use in many places where the roller bearing could be used. Another advantage of the roller type of bearing, from the manufacturer's standpoint, is that comparatively few rolls crack during the hardening operation.

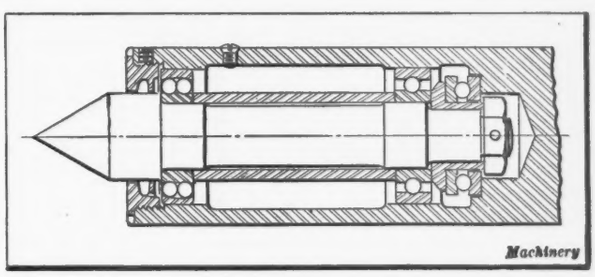


Fig. 13. Another Ball Bearing Lathe Center

The self-aligning feature of the bearing shown in Fig. 14 is of the utmost importance when the bearing is installed in railroad cars, as it reduces the strains on the axles, which are deflected to a considerable extent when the cars pass over curves at high speed. A recent examination of an S K F barrel-shaped roller bearing that had been in constant use on a train for a considerable period of time showed that the bearing was still in excellent condition. The train had been run 250,000 miles, so that the 36-inch wheels equipped with this bearing had each made approximately 145,000,000 revolutions.

This style of bearing could undoubtedly be used satisfactorily on heavy machine tools, such as car-wheel lathes and heavy milling machines where the pressure on the bearing is great. Yet it does not take up any more room, or at least very little more room, than is required for an ordinary bearing.

The bicycle, the automobile, and the flying machine would have been impossibilities without anti-friction bearings, and in other machinery, especially where high speed is required, ball bearings are gaining ground. In some instances, certain machine tools would not be successful, especially for production, if it were not for anti-friction bearings. It is also being demonstrated fully that where the pressure is great and the speed moderate, anti-friction bearings of the latest development are proving more satisfactory than solid bearings.

The writer believes that anti-friction bearings will win out, not only because they work well, but also because they are economical. In summarizing statements of various tests the writer has come to the conclusion that the heavy-duty roller bearing such as shown in Fig. 14 will last five times as long as the heaviest ball bearing used for the same service.

IMPORTANCE OF BALANCING HIGH-SPEED PULLEYS

By DONALD A. HAMPSON

Machine parts that are to rotate at high speeds must be properly balanced in order to prevent undue vibration. When vibration develops in a machine having a number of parts that rotate at very high speeds, considerable difficulty may be experienced in locating the source of the trouble. Pulleys, for instance, are sometimes the cause of vibration, but they are usually the last parts to be tested for balance when an attempt is made to determine the cause of excessive vibration. The methods employed to locate and correct the parts responsible for vibration are described in this article.

A high-grade floor grinder of the latest type, provided with ball bearings, steel hoods, etc., was recently installed in a certain shop. The countershaft appeared to be of excellent design and had steel hangers, a "jump" loose pulley, and grease cups for all bearings. When set up and belted, the machine could not be run because of the excessive vibration in the countershaft assembly. It was assumed that in a machine of this grade the countershaft must be all right and, accordingly, the stringers on which the countershaft was hung were stiffened. This did not eliminate the vibration and the shaft was therefore taken down and stripped.

Checking up, it was found that the shaft was not bent, and this, of course, showed that the trouble was caused by unbalanced pulleys. A cut taken on the inside of the pulley rim removed an eighth of an inch more on one side than on the other. The tight and loose pulleys were also turned on the inside, though they were out only a minor amount. When the shaft was again erected, it ran quietly without any perceptible vibration.

This countershaft was belted to run at the recommended speed of 700 revolutions per minute, yet the maker—one of the largest in the grinder field—had neglected to balance the countershaft pulleys properly, so that the countershaft assembly was badly out of balance. The manufacturer knew the speed at which the countershaft was to run, but failed to balance the pulleys, merely rounding the edges well toward the inside in the usual manner. A charge of about $25 for correcting this fault fell on the customer, who had faith in the engineering ability of the maker and had every reason to expect better workmanship in even what might be considered auxiliary equipment.

In connection with balanced pulleys, it is often surprising how little weight will cause vibration. A line of machines for cutting soft metals has a cutter-spindle running at 2500 revolutions per minute. There is a 4 by 4 double flanged pulley on each spindle, and originally these pulleys had been made solid of gray iron. In lightening the design of the whole machine, the pulleys were changed so that there was but a ¾-inch thick web in the center, and in machining the pulleys they were grasped on the inside by universal chuck jaws, it being assumed that this would make them amply true for the work.

When the first lot of machines reached the testing floor, they gave a good deal of trouble, which centered around the spindle and headstock, and as no one suspected such a small and well machined pulley, a great deal of time was spent in refitting bearings, strengthening foundations, fixing belts, and cutting tools of slightly uneven lengths that might throw the head out of balance—all without avail. Finally, one pulley was turned on the inside and on the hub, and the machine ran as smoothly as could be wished; previously, the pulley had been a good casting job and well finished in the shop, but that was not enough.

Another interesting problem was that of locating the cause of vibration in a high-priced automobile. The car ran very quietly at city speeds, but when run at from forty to sixty miles an hour, the noise and vibration was so great that a reduction in speed had to be made at once.

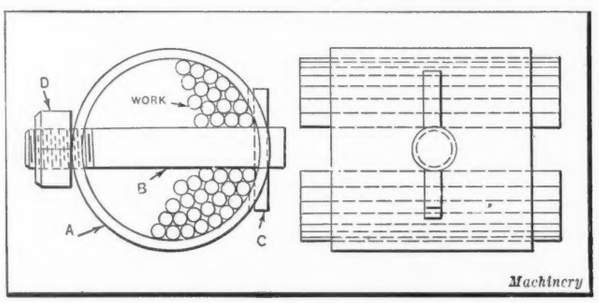
At the service station, everything had been inspected and all parts found to be in splendid shape—yet the car would not run at its guaranteed speed—something insisted upon by the purchaser. In desperation the driving shaft was removed, and because it was too long for the service station lathe, it was taken to a machine shop nearby to be tested for straightness. The machinist who was given the task noticed at once what was causing the difficulty so far as that shaft was concerned. More than that, he proved it by pencil and paper. The shaft was a rough bar which was upset on the ends, the ends then being turned and multiple-splined. In same way, one end had been centered off, the center of the rough bar being over 1/64 inch off the true center on an average throughout the whole length. With a shaft weight of 5 pounds, and assuming a speed of 2400 revolutions per minute (which was not the maximum), the machinist showed the astonished garage men that the centrifugal force of this unbalanced part was over 100 pounds. After the shaft was turned, there was no vibration at any speed within the range of the engine.

* * *

HOLDER FOR GRINDING PINS TO LENGTH

By HARRY MOORE

The device shown in the accompanying illustration has proved a great help in grinding the ends of length gages of the pin type. The only operation previous to grinding is sawing off the pins to length, a small allowance being made to provide for squaring up the ends on a disk grinder. Either tubing or iron pipe is used for the body *A* of the holder. This part is drilled through both sides in the center to take a stud or headless bolt *B* which has a cross-hole drilled through one end for the pin *C*. One side of the tube



Holder for grinding Pins to Length

A is slotted in the center so that pin *C* can be drawn into contact with the work by tightening the nut *D*.

In use, the holder is loaded with as many pins as can be put inside the tube, an equal number being placed on each side of bolt *B*. Before tightening nut *D*, the holder is held in a vertical position and the lower ends of the pins are rapped on a surface plate to make them approximately level. When nut *D* is tightened, it forces the cross-pin *C* against the gage-pins and presses them against each other and the wall of the tube. After the work is clamped in place, the holder is located in a V-block on the grinder table. Both ends of the pins can then be easily squared up and ground off to bring them to the required length.

* * *

The American Engineering Standards Committee, 29 W. 39th St., New York City, is planning to call a representative conference to consider the standardization of cast-iron pipe. The conference will determine whether this work of standardization should be undertaken, what its scope should be, how the work is to be organized, and what interests should be represented on the committees doing the standardization work.

Silent Gears for Machine Tools

Properties of Micarta Gears and Applications in the Machine Tool Field

By T. C. ROANTREE
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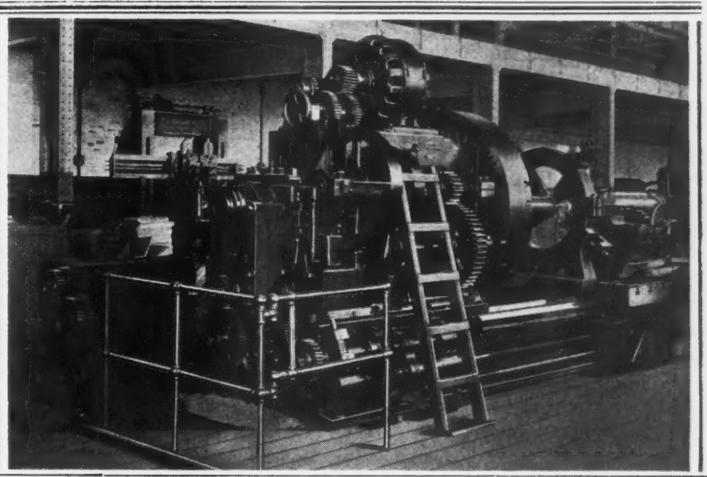
Westinghouse Electric & Mfg. Co.,
East Pittsburg, Pa.



IT is not until within comparatively recent years that the subject of gear noise has been given consideration by research men of mechanical and scientific training. The results of their work have brought forth the fact that the metallic noise from meshing gears frequently present in most manufacturing plants is the source of many physical disabilities, due to a severe strain on the nervous system. This strain not only has the effect of lessening the results of physical efforts, but also has a depressing effect on the mentality as the day progresses. Thus, leaving out of consideration the welfare of the employe—which is of paramount importance—the effect of noise on the quality as well as the quantity of the production is self-evident.

There were many efforts made to obtain a material for one of the mating gears that would have approximately the strength of metal, and at the same time eliminate, at least partially, the disturbing element of noise. A material of this nature that has had considerable success along these lines is rawhide, especially prepared and assembled between metal side plates; but this material swells or shrinks, depending upon climatic conditions, and whereas it has the desired effect of deadening the metallic noises, it requires frequent replacements due to its susceptibility to wear after a comparatively brief period of use. Further, it has been found impracticable to keep a supply of this material in storage, because of its deterioration in strength and the tendency of the layers to separate, as well as possible mutilation by rodents.

After years of effort and considerable expense, the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., produced a material known commercially as micarta. This material consists of an especially woven, high grade of duck weighing about 15 ounces to the square yard, which, before it is started through the various processes of manufacture required to bring it to the desired condition for use as a gear material, is thoroughly impregnated with the phenolic condensation product known as bakelite. The duck is passed through the bakelite (in liquid form) at a certain rate of speed, and then between two cylindrical metal rolls so arranged as to exert a given pressure on it, and finally through heated tunnels for drying.

The speed with which the duck cloth travels, the temperature of the liquid, the pressure exerted by the rolls, and the temperature and length of the drying tunnels, all have a distinct bearing on the quality of the product. The method of drying is quite important, for material in a moist or in an over-dried condition is equally inefficient. Between the impregnation process and the final formation into plates or boards are several operations that vary according to the uses to which the material is to be put.

The final formation into plates or boards 36 inches square, and of varying thickness from 1/16 inch to 3 inches, is performed in a very large press exerting several hundred tons' pressure. This pressure is accompanied by heat, and these two elements, combined with the element of time, form the three important factors in the operation. The control and variation of the pressure, heat, and time constitute the direct means of manufacturing the product in the condition in which it is best adapted for the purpose intended.

Strength and Properties of Micarta

Micarta, the material resulting from the process just described, when intended for gear purposes, has approximately the strength of cast iron. This does not mean that the tensile strength in itself is comparable, as micarta has a tensile strength of but 11,000 pounds per square inch, but its remarkable factor of resiliency combined with its ultimate strength enables it to withstand impact and abrasion to a degree that would eventually break or wear down a cast-iron tooth. These combined factors, in certain applications, have shown this material to have ten times the life or durability of rawhide, and in numerous cases it outwears cast iron. In addition, the resiliency helps to reduce the strain on the shafts due to the tooth impact, which thereby increases the life of the machine as well.

An example of the serviceability of this material is found in an application installed eight years ago—a pinion on a 35-horsepower motor driving a 14-foot Sellers planer. This planer has been in continuous use on heavy turbine work, and during the years of the war, this particular machine was in use practically twenty-four hours a day. During the period since the installation of the micarta pinion it has been found necessary to replace two cast-iron worm-gears and one chilled-iron one, and also a rack, owing to teeth having broken completely off in service, but the micarta pinion is still in good condition.

Changes of weather have no effect upon micarta and the fact that it is used successfully in thousands of automotive timing gear trains, where it is subjected to a constant flow of oil, sometimes reaching a temperature of 200 degrees F., is proof of its moisture- and heat-resisting qualities. The permanency of size required in such automotive applications is far more essential than in the average industrial uses.

In addition to these qualities, it is also rodent-proof, which makes it an excellent product for storage purposes. In industrial work, storage is often a necessity, for, having a

spare gear or pinion on hand frequently means that emergency cases can be handled with but little loss of time in production. The ability to do this represents a considerable financial advantage, in addition to the probability of maintaining an established production schedule.

Use of Side Plates for Reinforcement of Non-metallic Gears

Another advantage of this material, in comparison with others of similar nature, is that it is self-sustaining. The usual non-metallic material requires metal side plates which are held in place by rivets passing through the material. These plates extend to the top of the tooth, and it is consequently found advisable to have the face width of the non-metallic material in excess of the face width of the mating gear, in order to avoid the meshing of the side plates with the metal mating gear and thus the destruction of the quieting effect. It will be seen that this condition necessitates the use of more non-metallic material than the actual face width requirements, and thereby increases the initial expense of the gear.

It is only occasionally essential to use reinforcing side plates on micarta in face widths of less than 3 inches. Only in cases where the face width exceeds this, and there is also considerable horsepower load on each tooth, is it the best practice to use the side-plate assembly as a means of furnishing a harder material against which to upset the rivets and a means of preventing injury to the non-metallic material in case the key is sledge-driven. Even in such cases, however, it is necessary to use only the same face width as the mating gear, for there is no possibility of the meshing of the side plates, as they should end slightly below the root of the tooth.

Micarta Gears in Machine Tools

There are many manufacturers of machine tools who now use micarta to obtain quietness of operation of the machines they build. The original use of this material was as a pinion on a motor, and at present there are probably more applications of this nature than the use as a pinion or gear in machine tools, but its adoption in cases of the latter class is increasing. The field for the satisfactory use of this material is unlimited, as the machine tool industry is varied; the size of the gear required, whether very small or unusually large, places no limitations on the adoption of micarta gears. An idea of this condition may be obtained by consideration of the fact that micarta is now successfully used for pinions or gears by manufacturers of such special types of mechanical products as cash conveyors, coffee grinders, laundry machinery, magnetos, meat choppers, oscillographs, printing presses, pumps, refrigerators, speedometers, and tachometers. These applications are in addition to those on machine tools used in industrial plants, and on special machinery peculiar to the woodworking, mining, and textile fields.

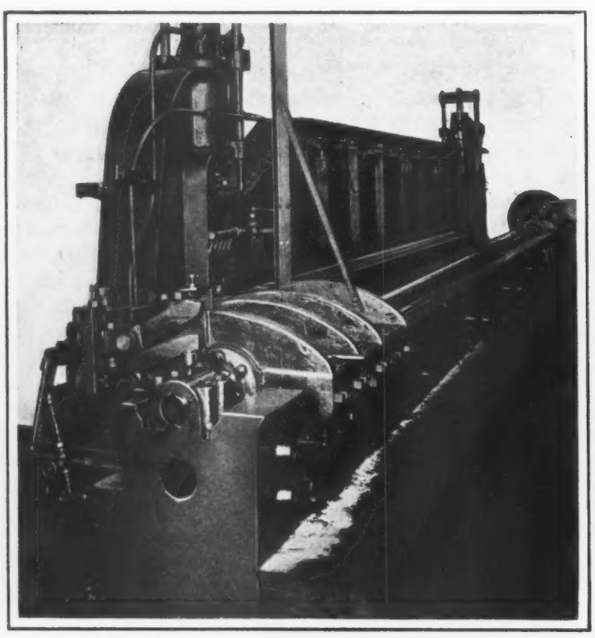


Fig. 1. Lock-bar Planer, with Micarta Pinion Drive

Fig. 2. Part of Motor and Micarta Driving Pinion for a Seven-foot Boring Mill

Specific Applications in the Machine Tool Field

The accompanying illustrations show some applications that have been made of micarta gears in machine tool drives. The heading illustration shows a 60-inch motor-driven lathe. The motor pinion is made from micarta, and is 8 inches in diameter, having a face width of 5⅞ inches, and is of 4 diametral pitch, transmitting power from a 30-horsepower motor. A steel intermediate gear, in turn, meshes with another micarta gear 8 inches in diameter, with a 3 9/16-inch face.

Fig. 1 shows what is known as a lock-bar planer, the drive of which is provided with a micarta pinion 13 inches in diameter, 8⅝ inches face width, 2 diametral pitch, which transmits power from a 75-horsepower motor. Fig. 2 shows part of the motor and driving pinion and gear of a 7-foot boring mill. The motor is 11½ horsepower and transmits motion to the machine through a micarta pinion 6 inches in diameter, 5½ inches face width, and 3 diametral pitch.

* * *

IMPORTANCE OF RAILROAD TRANSPORTATION

Our traffic demands double about every twelve years; and if the nation is to be properly served, our transportation facilities must be expanded at a corresponding rate. But during the last fifteen years, railroad development has, in the words of the late President Harding, been greatly "hampered" by regulations and restrictions, and in consequence, the traffic capacity of our railroads is but little greater than it was in 1910. Efficient operation is moving record-breaking tonnage today, but there is reason to fear that our railroads will prove inadequate for their task in the near future unless effective steps are taken soon. Transportation is absolutely essential for life as we know it. The whole social and industrial structure of the United States has been built upon the basis of a free movement of persons and goods. Throttle this movement, and troubles at once begin to multiply. Industry slows down; unemployment increases; fuel and other commodities, including certain food products, become hard to get; and prosperity disappears.—*E. M. Herr, President, Westinghouse Electric & Mfg. Co.*

Machining Hudson Super-six Lynite Pistons

Tooling and Inspection Equipment Installed for Producing Aluminum-Alloy Pistons

By CHARLES O. HERB

ALUMINUM pistons have been adopted in recent years by a number of automobile manufacturers principally in an endeavor to lighten the reciprocating parts of the engine. The weight of aluminum is only about one-third that of cast iron; therefore, a piston made from that material has much less inertia to overcome than a cast-iron piston, and consequently the thrust on the cylinder wall is lessened. Another advantage of these pistons is that because of the greater heat conductivity of aluminum, the carbon deposit on the piston-head is not so great and is more easily removed.

At first aluminum pistons were of the same construction as those made from cast iron, and many difficulties were experienced owing to the fact that aluminum expands twice as much as cast iron. Thus it was necessary to provide twice the amount of clearance between the piston and cylinder walls with the result that in starting a cold engine, piston "slap" was likely to develop until the pistons became heated. Lately, however, what is known as a "constant-clearance" aluminum-alloy piston has been developed, and the difficulties mentioned have been overcome.

This "constant-clearance" piston is slotted in such a manner that as it becomes heated, the walls simply close at the cut and the piston does not increase in diameter. Hence the clearance between the piston and cylinder walls always remains the same. The upper portion of the piston is also generally separated from the skirt by circumferential openings except where the piston-pin bosses are located. The Hudson Motor Car Co., Detroit, Mich., has adopted the aluminum-alloy piston, and furnishes the constant-clearance type in both the "Super-six" and Essex cars. The equipment used in producing the "Super-six" pistons, which are made from lynite, will be described in this article.

The construction of this piston will be clear by reference to Fig. 3. Slot *A*, which provides for a constant diameter, is 1/16 inch wide and cut at an angle with the axis of the piston so that it does not work entirely vertically in the cylinder but rather moves sidewise slightly as the piston reciprocates. The slot extends from the lower end of the skirt to slots *B* which separate the head from the skirt except in the vicinity of the piston-pin bosses. The piston is well ribbed internally to give sufficient strength in spite of the slots.

Operations on a Turret Screw Machine and an Automatic Lathe

The lynite castings are delivered to the machining department with the piston-pin holes roughly cleaned out and with high spots on the outer surfaces removed by snagging. The first machine operation is performed on a Warner & Swasey No. 2 turret screw machine equipped as illustrated in Fig. 1 except that a wrenchless chuck is now provided and tools are carried in only one station of the turret. Three tools are carried in this station for rough- and finish-boring the internal surface *C*, Fig. 3, of the skirt end, and facing edge *D*. These cuts are taken when the turret-slide is fed forward manually by the right hand of the operator.

Fig. 1. Boring and facing the Skirt End and center-drilling and countersinking the Boss on the Closed End of the Piston

Fig. 2. Facing, Turning, and Grooving Operations on the Piston, performed at One Time in an Automatic Lathe

At the same time that he is feeding the turret-slide forward, the operator, with his left hand, manipulates a lever at the head end of the machine, sliding toward the work a tool-holder in the spindle which carries a combination drill and countersinking tool, a facing tool, and a hollow end-mill. These tools produce a center in the boss of the closed end of the piston, face and turn the boss, and face a portion of the closed end in the vicinity of the boss. The jaws of the chuck grip the piston around its entire periphery except for a slight clearance between the jaws. The closed end seats against a ledge on each jaw so as to provide for facing the work to approximately the desired length. The average production on this operation in a nine-hour day is 1100 pistons.

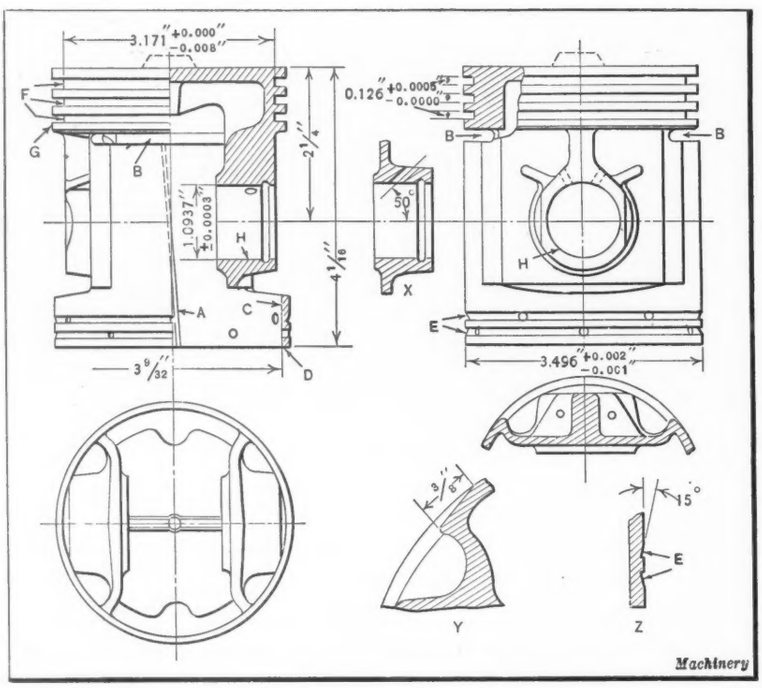


Fig. 3. Construction of the Hudson "Super-six" Lynite Piston of the Constant-clearance Type

The second operation on the piston is performed on a Fay automatic lathe equipped with twelve tools, as shown in Figs. 2 and 6. This consists of turning the piston its entire length with tool *L* as the front carriage is fed from right to left, and then rough-turning oil-grooves *E* with tools *M*, rough-turning ring grooves *F* with tools *N*, and turning surface *G* with tool *O* as the carriage is fed transversely toward the center of the machine.

Simultaneously with these operations the rear tool-holder rocks forward, so that tool *P* faces the closed end of the piston, tools *Q* finish-turn grooves *F*, and tool *R* bevels one side of ring *G*. The width of the ring grooves is checked by means of a "Go" and "Not Go" templet gage, and the diameter by means of a "Go" and "Not Go" snap gage. During this operation the bore of the skirt end seats on the cylindrical surface of the chuck, and the closed end is supported on a center, the piston being driven by means of a block on the chuck which engages the internal bosses for the piston-pin. The average production on this machine is 950 pistons per day. Minimum handling has been provided for by supplying long racks between the machines, having slightly inclined runways down which the pistons roll from one machine to the next.

Third and Fourth Operations

A small bench head equipped with a rotating angular milling cutter is next employed for producing a slight bevel on the inner edge of surface *D*, Fig. 3. The center of the closed end is seated on a tailstock center, and the operator brings the milling cutter into contact with the skirt by pulling a lever with his right hand as he holds the piston on the center with his left.

Finish-facing the closed end and finish-turning the rings at grooves *F* are next accomplished by means of three tools mounted in a special tool-block on the carriage of a Porter-Cable lathe, as illustrated in Fig. 4. The depth of the turning cuts is regulated by means of the micrometer slide screw, and the depth of the facing cut by means of a stop on the rod at the front of the machine, which trips the feeding clutch when the carriage has been traversed the required distance. Prior to removing the work from this machine the operator employs a file to bevel the various sharp edges lightly. The production is about 1250 pistons per day.

Following this operation snap gages are again used for checking the diameter of the various surfaces turned. The work is supported at the skirt end by seating the bevel produced in the preceding step on the corresponding surface of a mandrel. The closed end is held on a tailstock center as before and the work is rotated by means of a pin located eccentrically on the mandrel in such a way as to contact with the inside of the piston-pin bosses. Chips are blown from the work and the tools by compressed air emitted

Fig. 4. Finish-facing the Closed End and finish-turning the Rings

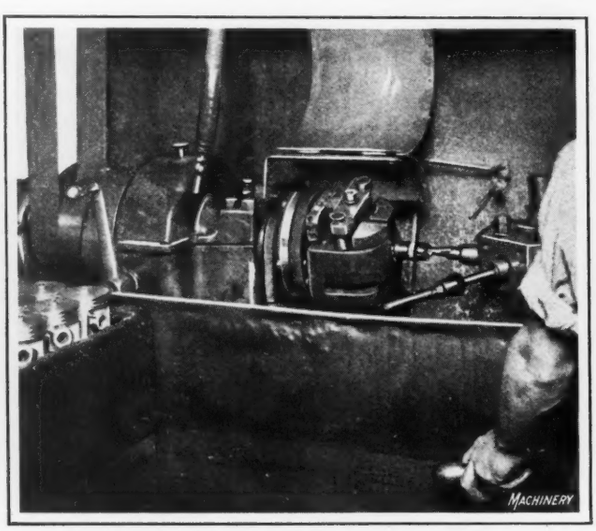


Fig. 5. Drilling and grooving Both Piston-pin Holes in One Set-up

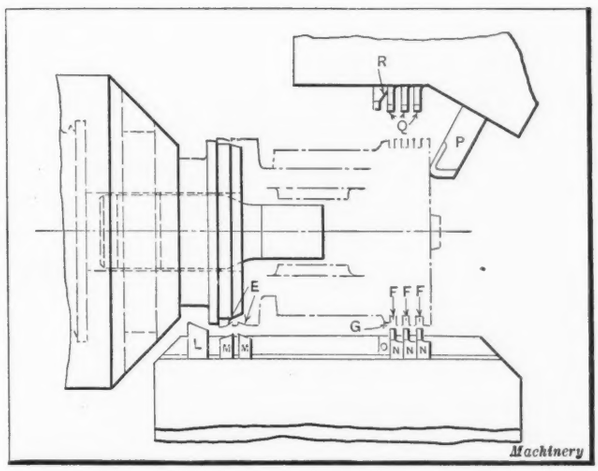


Fig. 6. Tooling Equipment provided on the Machine illustrated in Fig. 2

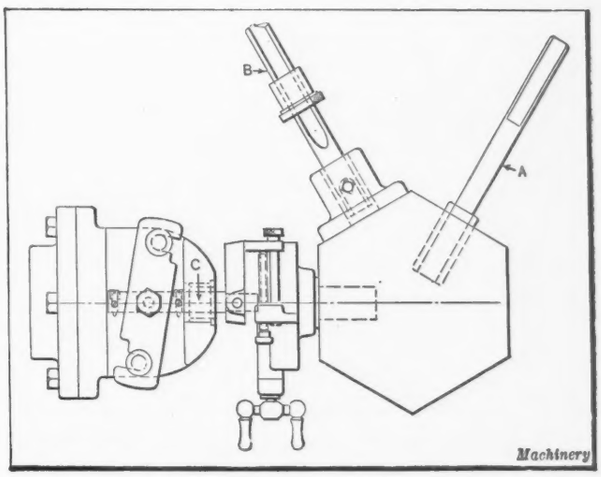


Fig. 7. Tooling Equipment provided on the Machine illustrated in Fig. 5

from a pipe which extends the length of the piston at the rear of the machine, and has a series of small holes in it. This pipe was dismantled from the machine at the time the photograph was taken.

Drilling and Grooving the Piston-pin Holes and Gashing Slots B

One of the most important requirements in piston manufacture is that holes *H*, Fig. 3, for the piston-pin be produced at right angles with the outer cylindrical surface. On the Hudson piston the tolerance is 0.001 inch per inch of length from the axis of the piston to the wall. A Warner & Swasey No. 4 universal turret screw machine is employed for this job, the machine being equipped with the tooling illustrated in Figs. 5 and 7, which serves to machine both holes. The chuck is of a box type, in which the piston is inserted with the axis of the piston-pin holes in the same horizontal plane as the spindle axis, and with the closed end seated in the circular recess of a block at the bottom of the chuck. The piston-pin holes are then lined up for the operation by advancing the turret-slide so that the long pilot *A*, Fig. 7, enters the holes.

After aligning the holes in this manner, the piston is clamped in place, pilot *A* withdrawn, the turret indexed, and the gun drill *B* fed through the holes. This tool serves to rough- and finish-drill and ream the holes in one step. After the gun drill has been withdrawn, the turret is again indexed and the boring tool *C* fed to position in the holes and then sidewise by means of the adjusting handle on the slide. This operation produces a ring groove in each piston hole, as shown at *X*, Fig. 3, to receive a retainer for the piston-pin. The production with this equipment averages 450 pistons per day. Holes are drilled around the flange of the chuck to insure proper balance, and coolant is constantly fed to the cutting tools during the operation. Any burrs that may develop are removed preparatory to subsequent grinding, by employing a piloted end-mill in a drilling machine.

Upon removal from this machine each piston is given a thorough inspection with the fixture illustrated in Fig. 8. The skirt end of the work seats on the beveled head of a plug held in one leg of the fixture, and the closed end is supported on a center in the opposite leg. A hardened and ground plug *A* is inserted through the piston holes so that a reading of the alignment of these holes and their relation to the periphery of the skirt end may be taken by means of the dial gages *B* and *C*. The truth of the closed end in relation to the other surfaces is determined by means of dial gage *D*. These gages read to 0.0001 inch.

Slots *B*, Fig. 3, are next produced on a Whitney hand milling machine, as shown in Fig. 9. The piston is seated in a simple chuck provided with four strips, so located as to form two vees, and having a round vertical post which extends through the piston-pin holes and locates the piston endwise and radially. The gash on one side of the piston is produced by feeding the work against a milling cutter, 3/16 inch wide, on the machine arbor. The table is then withdrawn, the work reversed in the fixture, and the table again fed toward the cutter to produce the

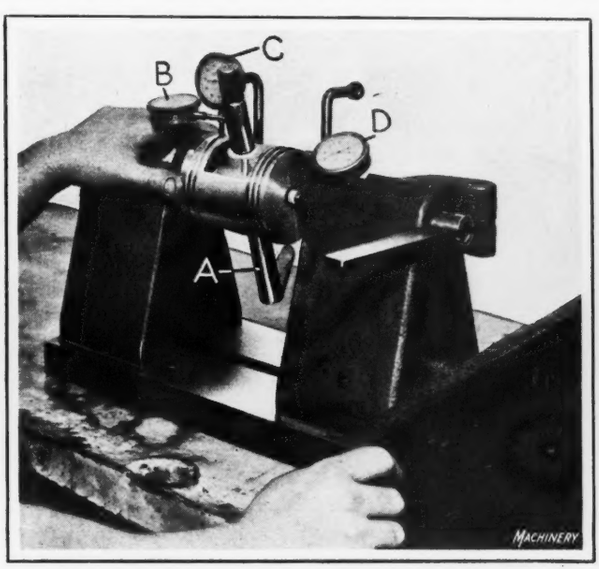


Fig. 8. Fixture employed in checking the Piston-pin Holes

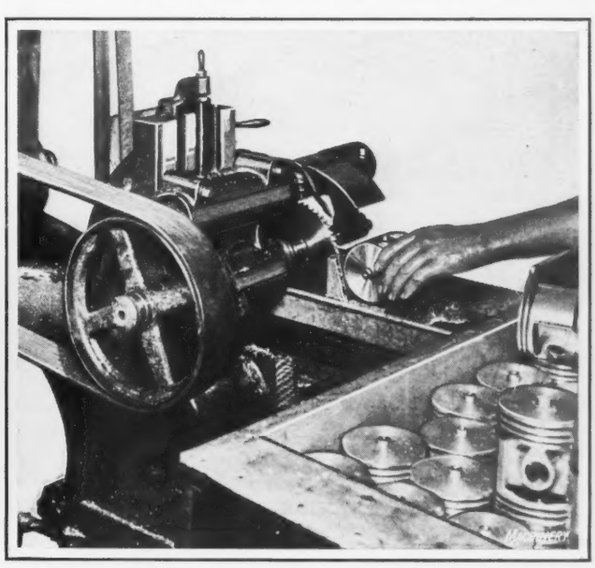


Fig. 9. Set-up used in gashing the Slots B, Fig. 3

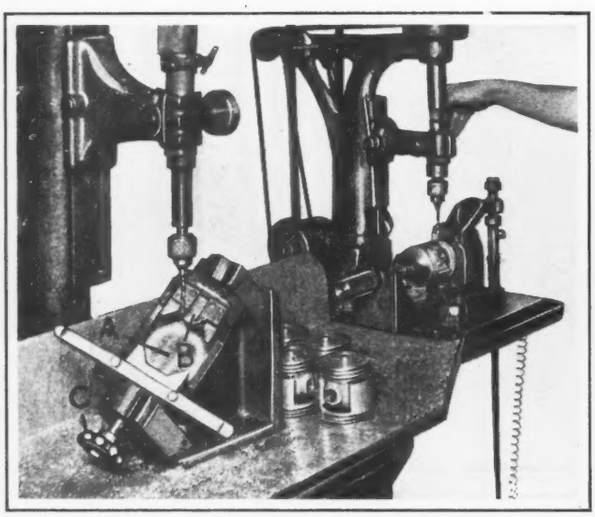


Fig. 10. Two Drill Jigs for drilling the Holes in the Piston-pin Bosses and in the Oil-grooves at the Skirt End

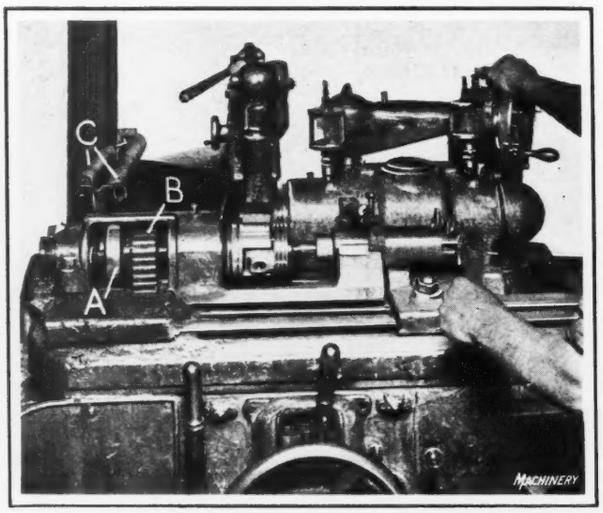


Fig. 11. Machine with an Oscillating Attachment for grinding Four Clearance Flats on Outside of Piston Wall

second gash on the opposite side. The depth of the gash is determined by the position of a table stop.

Drill Jigs of Unusual Construction

Six 3/32-inch holes are next drilled in each of the oil-grooves at the skirt end of the piston, the holes in one groove being staggered 15 degrees from those in the other. An indexing jig of unique design is used on a Sipp high-speed drilling machine for this operation. This jig may be seen at the right in Fig. 10, but this view shows the jig in place on a different machine from that on which it is now used. Its construction may be studied by referring to Fig. 12. Here it will be seen that the bore of the skirt end is seated on the cylindrical nose of part *A*, which has twelve V-grooves cut around it at the left-hand end, and a lug that extends between the piston-pin bosses on the inside and thus indexes the work in the manner to be explained. The work is held against part *A* by pushing clamp *B* against the closed end and giving the rod to which this clamp is attached a quarter turn so that the lower end of screw *C* engages a slot at right angles to a longitudinal slot in the rod with which the screw end is engaged when the clamp is pulled back.

At the opposite end of part *A* there is a ratchet *D* and a pawl *E*. This pawl is secured to a rod connected to a foot-treadle. After a hole has been drilled in the piston, the jig is indexed for the next operation by depressing the foot-treadle, which causes pawl *E* to descend and revolve the ratchet until a spring-actuated plunger *F* beneath the V-grooves in part *A* engages the groove succeeding the one it occupied prior to depressing the foot-treadle. The top of plunger *F* is wedge-shaped, and when depressing the foot-treadle to index the jig, the pressure brought against the left side of the plunger by the teeth of part *A* is sufficient to overcome the pressure of the spring in plunger *F* with the result that the plunger is forced down to permit part *A* to index. As soon as the operator feels that this plunger has entered the next V-groove, he releases the treadle, permitting spring *G* to raise the treadle-rod and pawl *E* into position for the next indexing.

Because of the holes being located alternately in the two oil-grooves of the piston, it is necessary to give the work a longitudinal movement of 3/16 inch either to the right or left at each indexing. This is accomplished by means of a bayonet cam *H* cut in part *A*, and a roller *I* which engages the cam groove. A workman soon learns to operate this jig rapidly, an average production of about 3 pistons per minute being obtained.

A second jig of interesting design is employed in drilling successively two oil-grooves through each piston-pin boss at an angle of 50 degrees with the axis, as shown at *X*, Fig. 3. This jig is shown at the left in Fig. 10. The skirt end of the piston is seated on the flat surface of part *A*, which swivels in bearings located at an angle of 50 degrees with the base of the jig, to suit the angle at which the holes are to be drilled. The radial position of the piston in the

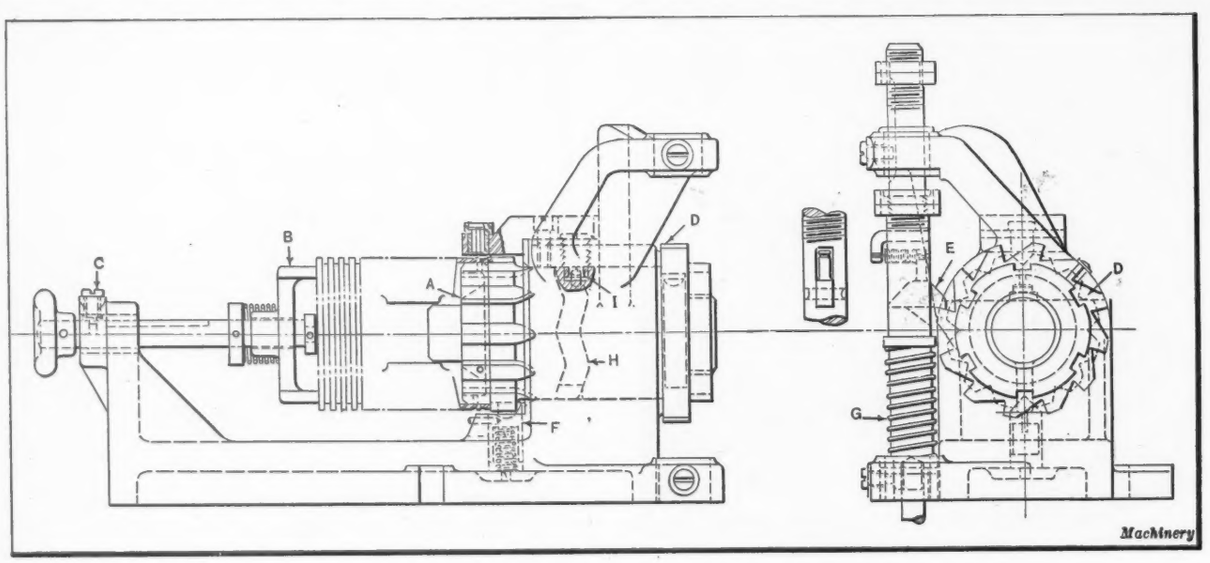


Fig. 12. Indexing Jig employed in drilling the Holes around the Oil-grooves near the Skirt End of the Piston

jig is determined by a pilot *B* engaging one of the piston holes as handle *C* is revolved to clamp the piston between V-grooves. For drilling a hole in one side of the boss, the operator tilts part *A* forward to a stop, and he tilts it back a similar amount for drilling the second hole. The piston is next unclamped, reversed in the jig, and reclamped for drilling the two holes in the opposite boss.

Grinding Operations

Clearance flats are ground ⅜ inch wide at the points where the periphery of the piston joins the ribs for the piston-pin bosses. A detail of one of these flats (of which there are four) is shown at *Y*, Fig. 3. A Landis plain grinding machine provided with a special oscillating attachment, as illustrated in Fig. 11, is employed for this operation. The work is seated at the skirt end on a beveled nose which has a lug extending between the piston bosses for driving the work. The closed end is supported on an ordinary tailstock center which is quickly operated toward and away from the work by means of a lever. An additional lever provides for clamping the tailstock center after the work has been positioned.

Mounted on the spindle of this attachment, there is a cam *A* which is of the same diameter as the outside of the piston and is cut away at four places corresponding to the flats to be ground. This cam is held constantly in contact with a roller fixed to the machine housing, and as the attachment is pivoted at the center of its spindle, it is rocked back and forth when the spindle rotates. The drive to the spindle of the attachment is through silent chain *B*. Uniform contact between the cam and the roller is maintained by two springs in the base of the attachment and springs *C*.

At the end of this grinding operation the skirt is again beveled slightly on the inside by making use of a bench head equipped with an angular milling cutter, in the same manner as previously described. This beveling step is performed a second time in order that the piston may be seated firmly for the subsequent operations. Then the piston is rough-ground its entire length on a Fitchburg grinding machine. The skirt end is again held on the beveled nose of a mandrel, and the closed end on a tailstock, a projecting pin on the mandrel being used to drive it. About 0.015 inch of stock on the diameter is removed, and the production averages 1100 pistons per day.

The finish-grinding operation on the same surfaces is performed on the Landis machine shown in Fig. 13, about 0.009 inch of stock on the diameter being removed. The method of supporting and driving the work is similar to the methods employed in preceding steps of the same nature. The production averages about 550 pistons per day. When it is removed from this machine, the piston is checked for diameter by means of the small fixture shown at the right-

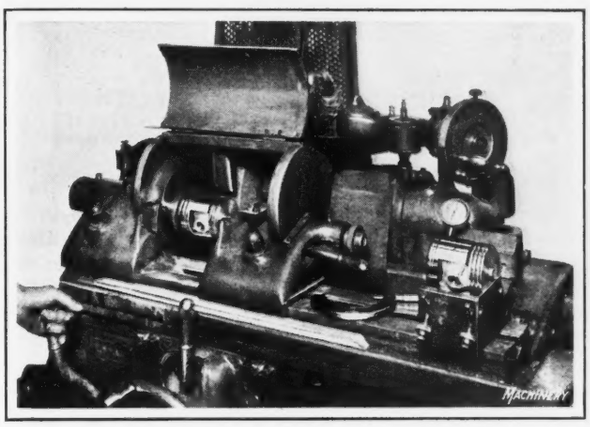


Fig. 13. Set-up and Inspection Fixture for Final Grinding Operation on the Piston

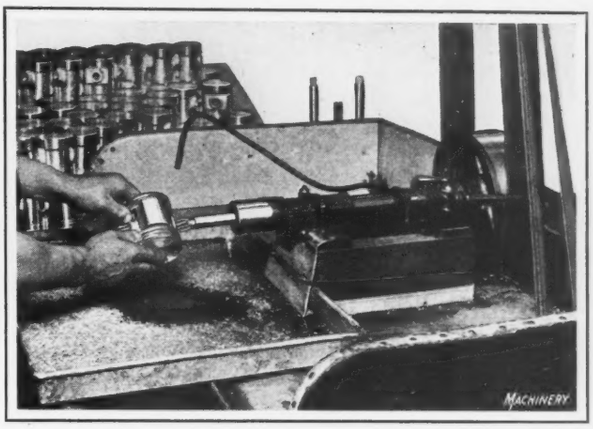


Fig. 14. Reaming the Piston-pin Holes by the Use of a Simple Bench Head

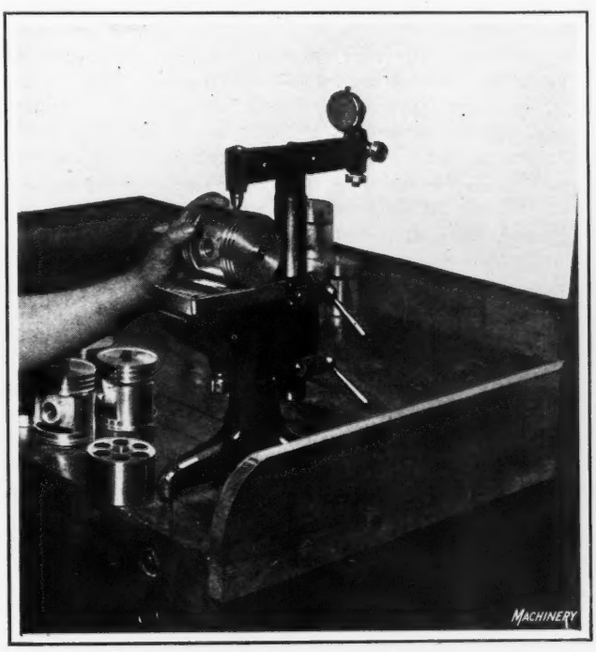


Fig. 15. Testing the Outside Diameter of the Piston by the Use of an Amplifying Gage

Fig. 16. Scribing a Line across the Closed End for aligning the Piston with the Connecting-rod

hand end of the table, which is equipped with a dial gage. The piston, near the skirt end and on one of the rings between the ring grooves, rests on the ball end of adjusting screws so located as to form vees.

Marking the Piston and Removing the Center Boss

Although a tolerance of 0.003 inch is permitted on the outside diameter of the piston, as indicated in Fig. 3, the pistons are assorted and marked according to differences of 0.0005 inch on the diameter. The exact variation from the nominal size is determined by means of an American amplifying gage in the manner illustrated in Fig. 15. The variation from the nominal diameter is first marked in crayon on the closed end by the inspector, and later marked by means of a hammer and stamp with one or more letters symbolic of the size. When each piston eventually reaches the assembly department, it is fitted to a cylinder which has been given the same symbol in its manufacturing department because it is of such a size that the desired clearance will be obtained between the piston and cylinder walls when this particular piston has been assembled in it. This practice insures that the clearance between the piston and cylinder walls will be the same in all cases within very close limits.

Removal of the center boss from the closed end is accomplished by placing the piston in a fixture mounted on the table of a Leland-Gifford vertical-spindle drilling machine. The skirt rests on a flat block on which it is slid from the left to permit a rod of diamond cross-section to enter the piston holes and prevent the piston from revolving during the operation. The flat block is screwed into another part in such a way that the piston may be clamped against an overhead surface by swiveling the flat block slightly. A 1-inch drill with the cutting edges ground at right angles to its axis is used to cut away the boss, this tool being piloted through a guide bushing. The depth to which it is fed is controlled by means of a stop.

Reaming the Piston-pin Holes and Cutting the Expansion Slot

The piston-pin holes are next reamed, as shown in Fig. 14, by sliding the piston over an expansion reamer held in a simple bench head. The reamer has a pilot at the front end that guides it through the holes, and a shank of sufficient length to permit the piston to be pushed on out of contact with the cutting blades. When the piston reaches this position, the operator takes hold of the front end of the reamer, pulls the reamer from the socket of the head, slips off the piston, and again inserts the reamer in the socket ready for the next piston. It will be seen from Fig. 3 that a tolerance of but 0.0003 inch is specified for the diameter of these holes, and this dimension is checked by means of a "Go" and "Not Go" plug gage.

Producing the expansion slot *A*, Fig. 3, is the final machine operation, and this is performed on a Toledo hand milling machine equipped with a cutter 1/16 inch wide. The work is held in a special fixture inclined at a considerable angle so as to reduce the length of table feed. The work rests on V-blocks, and is held securely by means of a round rod which is passed through a bushing in a leg on each side of the jig, and through the piston-pin holes. A taper gib is adjusted along the base of the fixture to tighten the work in place.

Weighing the Piston and Scribing the Closed End

After dipping the piston in gasoline to cleanse thoroughly from all chips, oil, and dirt, it is brought to the bench shown in the heading illustration where a scale is used to determine the weight of the piston within ¼ ounce. The weight is permitted to vary from ¼ ounce less than one pound to ¾ ounce over. A symbol for the weight is also stamped on the closed end.

The final operation on the piston consists of scribing a line across the center of the closed end in the same plane as the axis of the piston-pin holes. This line is later made use of in lining up the piston and connecting-rod unit in the engine cylinder. For this step, the piston is placed in a small fixture, as shown in Fig. 16, having a mandrel which is inserted through the piston-pin holes. The fixture rests on a clean surface plate. The line is then scribed along the closed end by employing a sharp tool-bit held in a special block, with its cutting edge in a horizontal plane at the necessary height above the base of the block, the block also resting on the surface plate. As the pistons are scribed they are placed in boxes according to the symbols that denote their diameter, to be conveyed to the assembling department. The Essex piston is essentially of the same design as the Hudson "Super-six" except for the diameter, and practically the same equipment is employed in its manufacture.

* * *

GRINDING BRONZE BUSHINGS

Some years ago the Norton Co. of Worcester, Mass., made public in *Grits and Grinds*, the results of investigations made by the company's research laboratories in regard to whether or not abrasive particles imbed themselves in the surface of ground cast-iron cylinders. The conclusion drawn from this test was that at least as far as the sample submitted was concerned, there was no abrasive embedded in the surface of the metal.

Recently, this question was reopened. This time, instead of the subject being cast-iron cylinders, it was bronze bushings. Now, bronze offers but little resistance to penetration, and still has the property of being fairly tough. If there is any possibility of a surface being impregnated with abrasive particles as a result of the grinding operation, it would seem that this metal would be more likely to be affected than almost any other.

In order to settle this question, another interesting experiment was carried out by the laboratories. Three bronze bushings were ground internally by crystolon vitrified wheels, varying in degrees of hardness and fineness within the range of grains and grades commonly used for this work. The bushings were then split by means of a hacksaw. One-half of each bushing was examined chemically, the metal being dissolved for the purpose of determining if any residue remained and if this residue contained silicon carbide. The other half was examined by powerful magnification for the presence of silicon carbide grain. Then the surface was scraped and the chips examined microscopically.

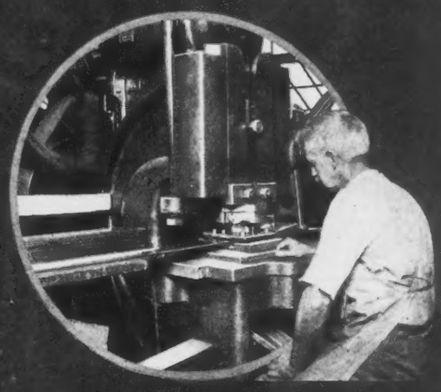
The results are interesting and conclusive. In no case was it possible by either method to detect the presence of abrasive. The same conclusion as was arrived at with cast iron may be drawn, namely, that no abrasive is embedded in the metallic surface as a result of the grinding operation.

* * *

SAVING GASOLINE BY CARBURETOR ADJUSTMENT

Substantial savings of gasoline by the periodical adjustment of carburetors based on the results of analysis of exhaust gases from automobile engines are declared to be feasible by the Department of the Interior following experiments made by the Bureau of Mines on the fleet of motor trucks used by the Government Fuel Yard in Washington. As the result of carburetor adjustments made by gas analysis in the bureau's experiments, an actual increased efficiency in mileage and saving of gasoline amounting to 22 per cent was attained in the following month. The tests demonstrate that a portable carbon dioxide indicator for testing the exhaust gases of a motor vehicle gives a positive indication of the carburetor adjustment, removes all guesswork of such adjustment, is perfectly feasible, and is almost indispensable to a company having ten or more large trucks in service, especially if supplied with adjustable carburetors.

Progressive Dies for Piercing, Bending and Blanking



By I. BERNARD BLACK

POWER presses are now being used successfully in the production of many parts that were formerly believed to be too complicated to be made with any type of press die. Less complicated parts that in the past have required the use of several separate dies are now made by a series of operations in one die that produces a finished part at each stroke of the press. A die of the latter type is sometimes called a "follow" or "progressive" die, and is also referred to as a "combination set of tools" by diemakers.

A die of this kind employed to produce the locating bracket shown in detail in Fig. 1 is described in the following. This piece is used in an electrical device, and as it forms a certain part of a magnetic circuit, it is required to be made of Norway iron. The stock is obtained in strips 10 feet long, 0.110 inch thick by 2 11/16 inches wide. The metal strip is fed into the press from right to left by means of a double roll feed. The press is operated at a speed of 120 strokes per minute, and the gross production per hour is 6500 finished parts.

In Fig. 2 is shown the stock lay-out of the part. It will be noted that there are five stations, the stock from which a single part is punched being successively located in five different positions on the die. It was found that about 107 feet of stock was required to make 1000 pieces, and that the approximate weight per thousand pieces was about 106 pounds. The nature of the operation performed at each station of the die will be described in the regular order in which the work progresses. At the first station, located at the extreme right-hand side of the die, part of the stock is blanked out to form the rounded section of the end of the piece shown bent at right angles to the main body in Fig. 1. The part blanked out in this operation is shown in cross-section at *A*, Fig. 2. The three holes *B* are also pierced at the first station.

At the second station the stock is blanked out as indicated by the cross-section at *C*. Thus it will be noted that the rounded section of the bracket is produced in two blanking operations, in which stock is removed as indicated by the cross-sections *C* and *A*. The slot in the work is also pierced at the second station, as indicated by the cross-section at *D*. In this operation, the stock is located by pilots *E*, which enter two of the holes *B*, pierced at the first station. At the third station, the two projecting pins or bosses *F* are pressed up from the stock. At the fourth station, the rounded end of the part is bent down, and at the fifth station the piece is blanked out. Referring to Fig. 4, the dotted lines at *D* indicate that a slot is cut in the die which extends from the die opening at the fourth station to that of the fifth station. This slot is made wide enough to clear the bent down end of the piece as the stock is fed forward to the next position.

The stripper plate is shown in place in the plan view of the die, Fig. 4. It will be noted that the stock guides *A* are actuated by springs *B*. These guides keep the stock pressed against the opposite side *C* of the guide strip shown at *U*, Fig. 3. The plate *O*, Fig. 4, was required to be cut away, as indicated by the dotted lines at *E*, in order to provide clearance for the scrap.

Referring to the front elevation of the punch and die shown in Fig. 3, parts *A* and *C* are the punches that blank out the part of the stock indicated by the cross-sections shown at *A* and *C*, Fig. 2. The punches *B*, Fig. 3, pierce the holes *B* shown at the first station Fig. 2. Part *D*, Fig. 3, is the punch that pierces the slot in the bent-up end of the piece. Part *E* is one of the pilots that enter the holes pierced by the two outside punches *B*. The punch *G* partly pushes the section shown by dot-and-dash lines at *G*, Fig. 2, out of the stock, in order to force up the metal that forms the projecting pins or bosses.

The part *H*, Fig 3, bends the rounded end of the piece down at the fourth station. This punch is provided with a step that is designed to strike the outer point of the rounded end before the bending operation actually begins. It will be noted that a spring-actuated pad *J* is provided for

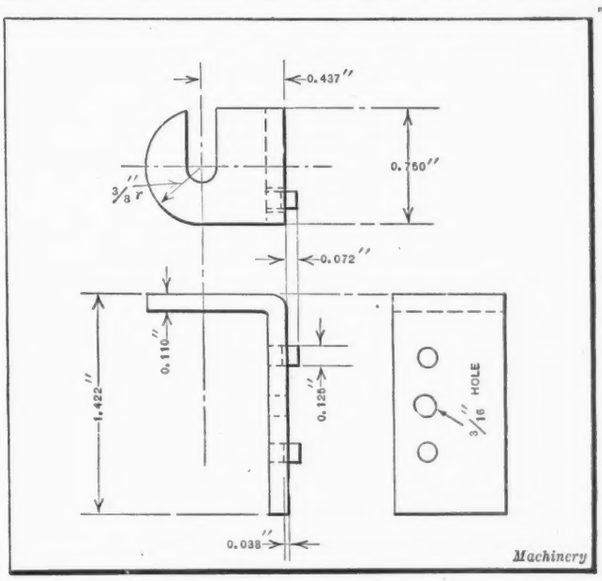


Fig. 1. Details of Bracket produced in Progressive Type of Die

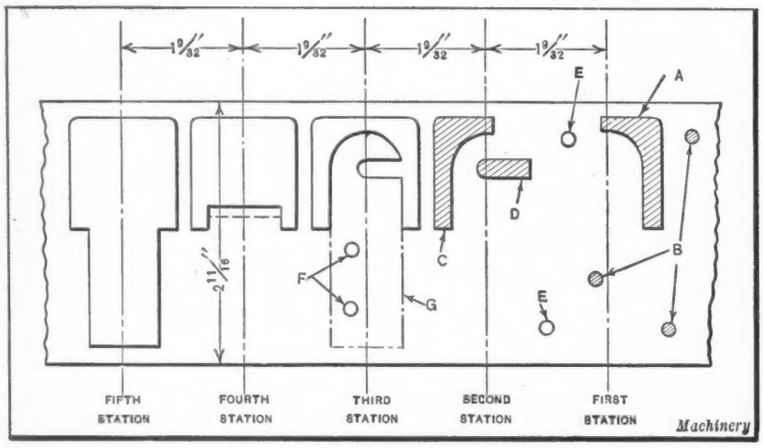


Fig. 2. Stock Lay-out of Part shown in Fig. 1

punch *H*. This pad, with the pilot *K*, which enters the central hole *B* (Fig. 2) pierced at the first station, prevents the metal from being drawn or pulled to one side. The pilot *K* thus prevents the projecting bosses or pins from being damaged. The incorporation of the bending punch *H* in the die is a feature of particular interest in view of the fact that follow-dies of this type are generally used for work that requires only piercing and blanking operations. The pieces are blanked by punch *L*, and fall through the die into a receptacle under the press. It was found necessary to support the piercing punches *B* at the first station by inserting bushings in the stripper plate *V*.

A novel feature of the die is the method employed for forcing up the metal that forms the projecting pins or bosses. On the downward stroke of the press, the punch *G*, Fig. 3, pushes the section indicated by dot-and-dash lines *G* in Fig. 2 partly through the stock, or a distance of 0.072 inch, thus causing the part *M*, Fig. 3, to recede into the die. Pins *N*, in turn, cause plate *O* to compress spring *P*. The punches *R*, being stationary and backed by the plate *S*, push up the two bosses on the work when the sheet metal stock is pressed down over them. This also causes the two spring-backed pins *F* to recede into punch *G*.

The two adjustable screws *W* were provided in order to hold the stock down flush on the die, for on the upward stroke of the press the heavy sub-press spring *P* reacts against plate *O*, and the pins *N*, which are in contact with part *M*, push the section shown in dot-and-dash lines *G* in Fig. 2 back into the stock, thus leaving the bosses on the upper side of the stock. The spring-backed pins *F*, Fig. 3, in punch *G* are returned to their normal positions by the action of springs *T*.

In Fig. 5 is shown the plan view of the punch-holder block. The holes *T*, shown in part *J*, clear the bosses or projecting pins formed in the preceding station, so that the entire face of part *J* is in contact with the stock during the bending operation.

* * *

Trade Information Bulletin No. 157, published by the Bureau of Foreign and Domestic Commerce, Washington, D. C., deals with the foreign trade of the United States for the fiscal year 1922-1923. The bulletin contains about fifty pages of condensed information, both in tabular and text form, relating to foreign trade.

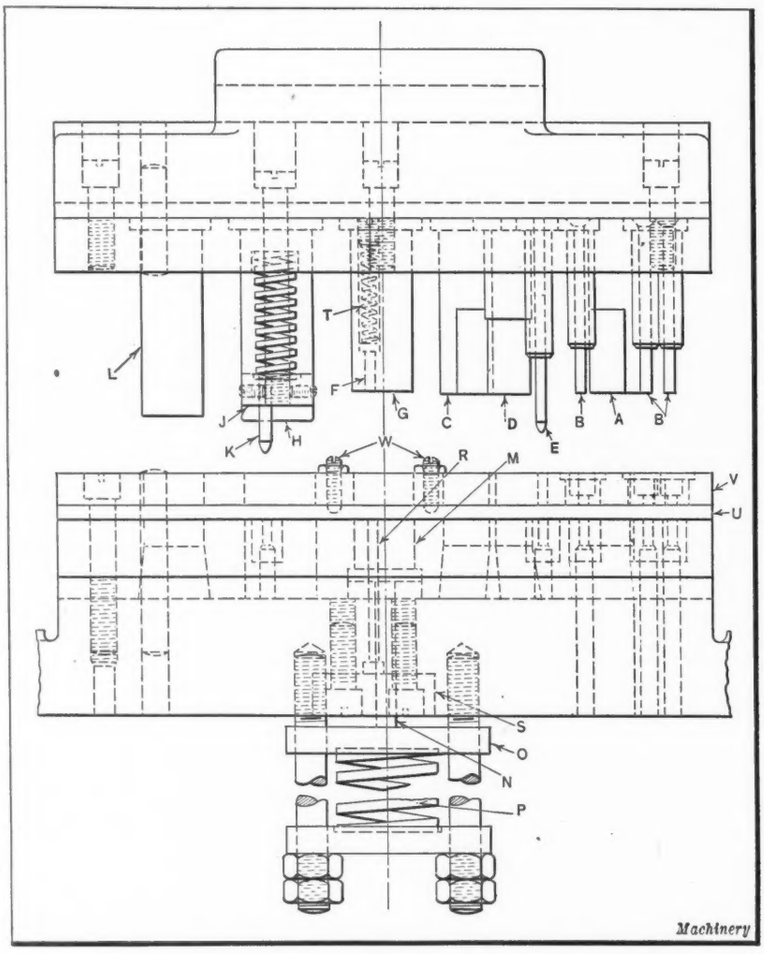


Fig. 3. Front Elevation of Punch and Die for producing Part shown in Fig. 1

THE GRAIN SIDE OF THE LEATHER BELT

By LOUIS W. ARNY, Secretary
Leather Belting Exchange, Philadelphia, Pa.

Research into the subject of the transmission of power by belting has brought to light some interesting minor points which have a good deal of bearing on successful transmission. One of these is the importance of the grain, or hair, side of leather. Leather itself is a peculiar combination of fibers, different from anything that we know in artificial production. These fibers are interlaced in such a way that, though firmly anchored to the two surfaces, they still have an abundant play on each other. They are more like a felted fabric, except for this anchorage. The grain surface, or the actual cuticle, is of a different fiber, less strong and less flexible than the main body of the hide, but tougher and less penetrable, answering excellently its main purpose, which seems to have been the protection of the animal and the furnishing of a bed for the hair. This grain or surface of the leather has a peculiar affinity for a pulley, or, in other words, a high coefficient of friction. Just why this is so has not been determined scientifically, but apparently there is some suction effect produced between the belt and the pulley.

In a large number of experiments conducted at the Research Laboratory of the Leather Belting Exchange Foundation at Cornell University, it was demonstrated beyond question that when the grain side is next to the pulley the belt will pull a much larger load than when the flesh side is next to the pulley. Another interesting experiment in

the same line was conducted by R. F. Jones, research director at the same laboratory, in which he took a 4-inch belt and tested it with the grain side next to the pulley, obtaining a transmission of 34 horsepower at 1½ per cent slip, and 64 horsepower at 3 per cent slip. This belt was then taken from the pulley and returned to the factory that made it, and there was removed from the grain side, by a special machine, a very thin split, approximately 1/200 inch thick, after which the belt was returned to the laboratory and again put on the testing machine under exactly the same conditions as before. This time it was impossible to obtain a greater transmission than 24 horsepower at 1½ per cent slip, or 32 horsepower at 3 per cent slip, the tension in both cases being 288 pounds, or 72 pounds per inch of width.

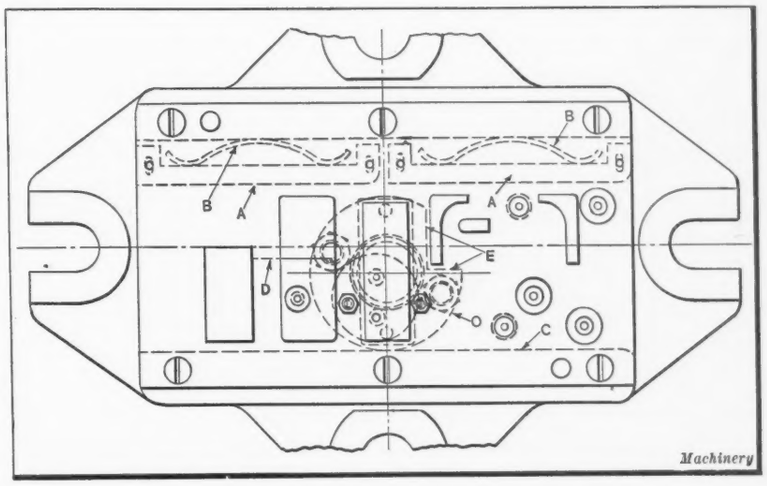


Fig. 4. Plan View of Die shown in Lower View of Fig. 3

It will be noted that the tests were made on the same belt and on the same side of the belt, that the belt had been well "run in" under the first test, and that any advantage resulting from this "running in" should have been realized in the second test. This condition is quite familiar to leather belting manufacturers from numerous experiments, but none have been so thorough and conclusive as the one cited. The point it is desired to bring out here is the importance of this particular film of grain which had been removed. About 1/200 inch in thickness, it contained that peculiar quality that enabled the belt to make a close contact with the pulley. With this quality, the belt attained high transmission values, but without it the transmission value was low.

The principal point to be learned from this investigation is the necessity of taking good care of the grain side of belts. In practice, the belts should be kept clean, and free from the pasty "dopes" which are so numerous on the market. The accumulation of dirt, together with the pasty "dopes," must fill up the cavities in this surface that are responsible for the suction effect, and largely reduce the transmission qualities of the belt. In line with this, the leather belting manufacturers, profiting by the information that has come to them from their laboratory, have been giving serious attention for a number of years to this subject of improving the transmission quality of their product, with the result that they have made great strides in this direction.

A leather belt should drive by natural pulley adhesion, that is, without undue tension. A belt that is placed on a horizontal drive at an initial tension of 72 pounds per inch of width, and where either pulley is free to revolve, has this tension distributed evenly between the two strands of the belt, 36 pounds on the top strand and 36 pounds on the bottom strand, but as soon as a little motion is given to the belt, the top strand begins to elongate and the tension on that strand is reduced, and when full speed is attained and the load is applied, the top side has dropped down materially and the tension on that side has been reduced to nothing more than the weight of the belt. Under these conditions an ordinarily good leather belt will transmit its full rated load, and for the present, at least, this is the measure of its capacity, and all that should be asked of it. To be sure, it has an overload capacity of approximately 100 per cent, but this should be made use of only in an emergency.

There is a strong feeling in some directions that with the improvements that the manufacturers have been able to make as a result of their research work, the rated load now could be somewhat increased and still be conservative. Most of the horsepower tables are based on an effective tension of 55 pounds per inch of width, but many believe that this could be safely increased to 60 or even to 65 pounds, if there were some practical way of measuring the tension of running belts.

* * *

A project is under way for the construction of a tunnel six miles long under the Rocky Mountains, which will provide an air-line route from Denver to Salt Lake City. The west entrance of the tunnel will be near the head waters of Frazer River, and the east portal near the present Tolland Station. The east portal is to be at an altitude of 9200 feet above sea level, and the west portal, 9100 feet. The tunnel will carry only one line of track.

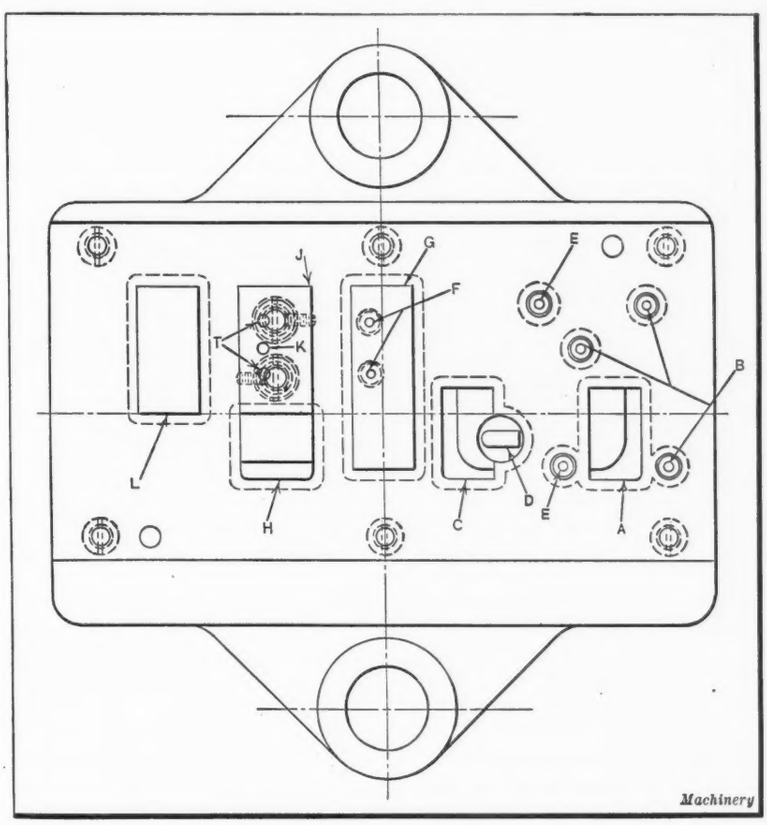


Fig. 5. Plan View of Punch shown in Upper View of Fig. 3

Proposed Standardization of Gearing

AT the semi-annual meeting of the American Gear Manufacturers' Association, held October 25 to 27, the nomenclature committee submitted a report prepared in cooperation with the various standard committees of the association. This report covers definitions of all the terms ordinarily used in connection with gear design and gear cutting. These definitions, as given in the following, are also approved by the sectional committee of the American engineering standards committee. On this sectional committee both the American Gear Manufacturers' Association and the American Society of Mechanical Engineers are represented. Any mechanical man interested in the subject of gearing is invited to offer suggestions or criticisms. Communications should be addressed to the secretary of the American Gear Manufacturers' Association, T. W. Owen, Room 107, 2443 Prospect Ave., Cleveland, Ohio.

In the definitions given in the following, it is understood that when a dimensional value is defined, the dimensions are based upon theoretical conditions and proportions.

Addendum is the distance, normal to the pitch surface, from the pitch surface to the top of the tooth.

Arc of action is the angular distance a tooth travels from the point where it first makes contact with its mating tooth until it leaves contact (sometimes called angle of action).

Active face is the length of the working surface of the teeth in the axial plane.

Arc of approach is the angular distance from the point where tooth contact begins to the pitch point.

Arc of recess is the angular distance from the pitch point to the point where tooth contact ceases.

Addendum angle is the angle between the pitch cone and the face cone in a plane containing the axis (also called the increment angle).

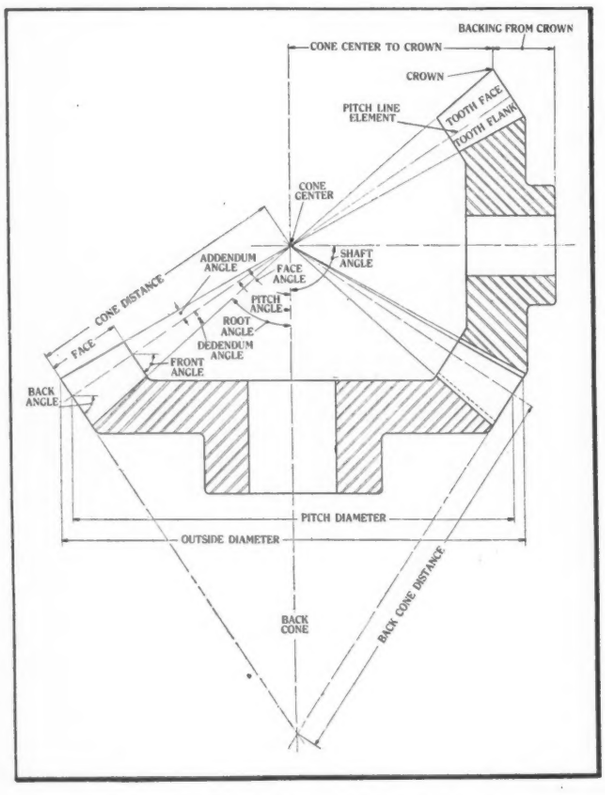


Fig. 1. Standard Notation used for Bevel Gearing

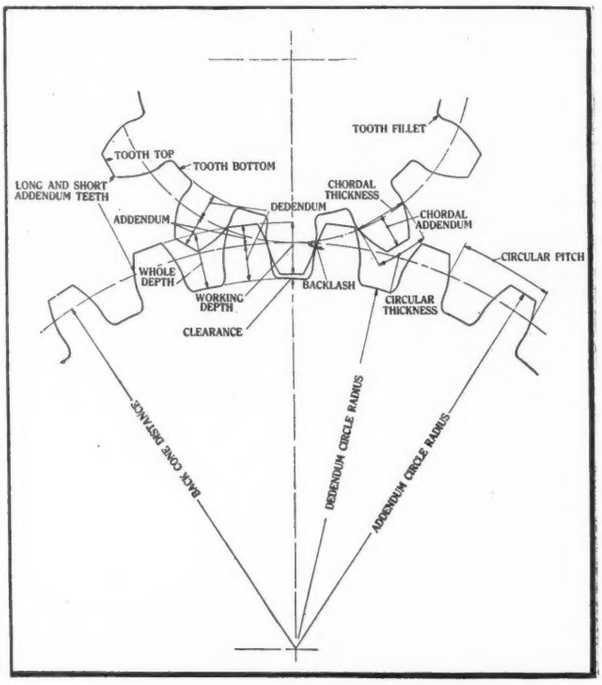


Fig. 2. Standard Notation used for Bevel Gearing

Angular bevels are bevel gears which are to operate on shafts having an included angle other than 90 degrees.

Backlash is play between teeth of mating gears.

Base circle is that circle from which a line is unwound to generate the involute curve.

Backing is the distance parallel to the axis from the crown to a shoulder or hub extension.

Back cone radius is the distance perpendicular to the pitch surface from the pitch line to the axis. (This distance is also called virtual pitch radius.)

Back cone is the cone generated by swinging the back cone radius about the axis of the gear.

Back angle is the angle included between the plane of the pitch circle and a plane tangent to the large end of the tooth (sometimes called the edge angle).

Bottom land is the surface of the gear body between adjacent teeth.

Center distance is the shortest distance between the axes of mating gears.

Circular pitch is the distance on the circumference of the pitch circle between corresponding points of adjacent teeth.

Clearance is the shortest distance between the top of a tooth and the bottom of its mating space.

Circular thickness is the thickness of a tooth along the pitch line.

Chordal thickness is the length of chord subtended by the circular thickness arc.

Chordal addendum is the greatest perpendicular distance from the top of the tooth to the chord subtended by the circular thickness arc (sometimes referred to as corrected addendum).

Cone center is the apex of the pitch cone.

Cone distance is the shortest distance from cone center to any point on the pitch circle (sometimes called apex distance).

Crown is the edge formed by the intersection of the face cone and the back cone.

Cone center to crown is the distance parallel to the axis from the cone center to the crown of gear.

Dedendum is the distance, normal to the pitch surface, from the pitch surface to the bottom of the tooth space.

Dedendum angle is the angle between the pitch cone and the root cone in a plane containing the axis (also called the angle of decrement).

Diameter increment for bevel gears is the amount added to the pitch diameter to obtain the outside diameter.

Diametral pitch is the number of teeth divided by the pitch diameter in inches.

Face angle is the angle between a plane tangent to the top of a tooth and the axis.

Gear ratio is the number of teeth in gear divided by the number of teeth in pinion, or number of threads in worm.

Helical gear is one in which the teeth are formed along a helix. (Helical gears may run on parallel axes, in which case one gear has a right-hand helix while its mating gear

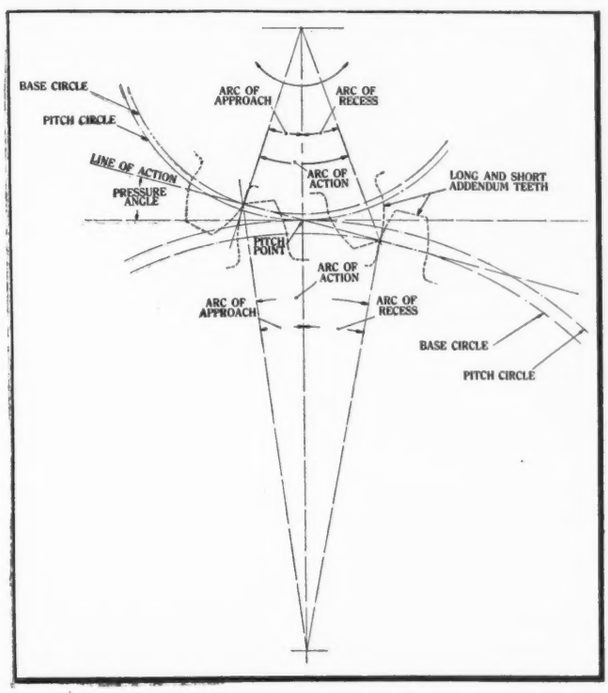


Fig. 3. Standard Notation used for Bevel Gearing

has a left-hand helix. Helical gears may also run on axes which are not parallel. In these cases the helices of both gears may be of the same hand. Such gears are commonly miscalled "spiral gears.")

Helix angle of a helical gear is the angle between the helix at the pitch line and the axis of the gear.

Herringbone gear is a gear composed of two helical sections, one right-hand and the other left-hand.

Interchangeable gear system is one which permits gears of any tooth numbers of the same pitch to run together.

Interference means contact between mating teeth at some other point than along the line of action.

Involute normal pitch is the normal distance between two successive and corresponding involute tooth surfaces. (It is equal to the circular pitch multiplied by the cosine of the pressure angle.)

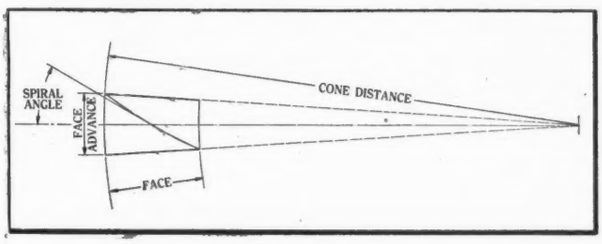


Fig. 4. Standard Notation used for Spiral Bevel Gears

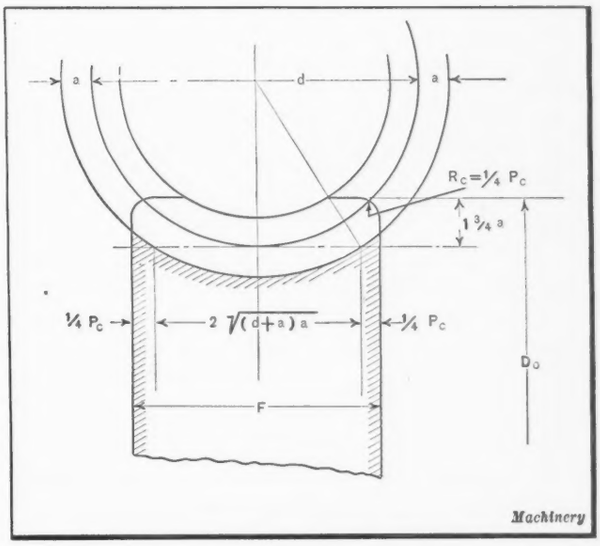


Fig. 5. Formulas for Worm-gears engaging with Single- and Double-thread Worms

Line of action is the line along which all contact between mating teeth occurs. (On correct involute gears this line of action is the common tangent to the base circles of mating gears. This line is also called the path of contact.)

Long and short addendum teeth have a longer addendum on the teeth of one member than on the mating gear.

Normal circular pitch is the distance on the pitch surface along a helix perpendicular to the helix angle of a helical gear from one tooth to the corresponding point of the adjacent tooth. (It is commonly miscalled the normal pitch.)

Normal diametral pitch is that which corresponds to the normal circular pitch.

Normal pressure angle is the angle included between a line perpendicular to a normal tooth profile at a point on the pitch surface and a plane tangent to the pitch surface at that point.

Outside diameter is the diameter of the greatest circle which contains the tops of the teeth.

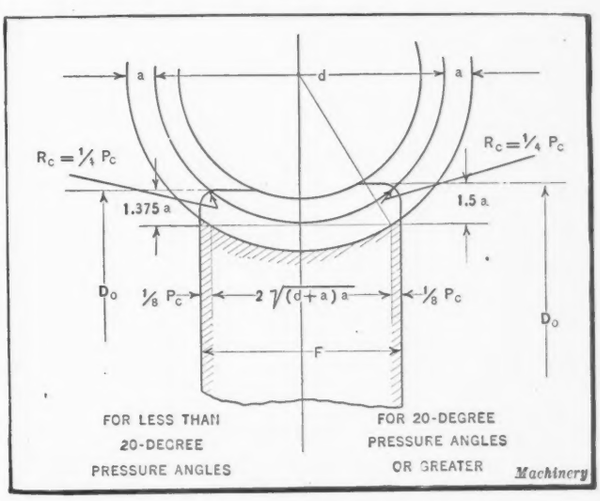


Fig. 6. Formulas for Worm-wheels engaging with Triple- and Quadruple-thread Worms

Pitch angle is the angle between a plane tangent to the pitch cone and its axis.

Pitch circle is the circle formed by the intersection of the pitch surface and a plane perpendicular to the axis.

Pitch diameter is the diameter of the pitch circle.

Pitch point is the point of tangency of the pitch lines of two mating gears.

Pitch line element is a line, curved or straight, on the pitch surface, formed by the intersection of the tooth and pitch surfaces.

Pressure angle is the angle between the line of action and a line tangent to the pitch surface at the pitch point.

Root angle is the angle between a plane tangent to the bottom of the tooth space and the axis.

Straight bevel gear is a bevel gear whose pitch line element is a straight line.

Shaft angle is the included angle between the shafts upon which a pair of bevel gears operate.

Top land is the surface of the tooth which is farthest from its supporting body.

Tooth bearing is the area of the working surface of a tooth which has contact with its mating tooth.

Tooth top is a line in the top land joining the tooth faces.

Tooth bottom is a line in the bottom land joining the tooth flanks.

Tooth face is the surface between the pitch line and the top of the tooth.

Tooth flank is the surface between the pitch line and the bottom of the tooth space.

Tooth fillet is the fillet at the bottom of the tooth flank joining the bottom of the tooth space.

Throat increment for worm-gears is amount added to the throat diameter to obtain the outside diameter.

Under-cut refers to that condition where part of the conjugate surface of the flank has been cut away.

Whole depth is the greatest depth of tooth space perpendicular to the pitch surface.

Working depth is equal to the sum of the addenda of mating gears. (It is also equal to the whole depth minus the clearance.)

Bevel Gear Definitions

The accompanying illustrations show the bevel gear nomenclature submitted by the committee. In the case of bevel gears, the definitions are given by actually showing the dimensions or tooth parts on drawings. Long and short addendum gears have been chosen as examples merely to indicate that the definitions apply to all kinds of bevel gears.

Proposed Stub Tooth Standard

The committee on tooth standardization proposed the following standard for stub teeth. In deciding upon this standard, the committee carefully studied the characteristics of the three systems of stub teeth that have been most generally used in this country. From these systems have been worked out formulas which produce teeth that do not introduce entirely new elements. The committee therefore recommends these stub-tooth dimensions as an American standard.

1. The use of both diametral and circular pitches.
2. A pressure angle of 20 degrees.
3. Pitch diameter $= \frac{N}{D.P.}$ or $0.3183N \times C.P.$
4. Outside diameter $= \frac{N + 1.5708}{D.P.}$ or $P.D. + \frac{C.P.}{2}$
5. Addendum $= \frac{0.7854}{D.P.}$ or $0.25 \times C.P.$
6. Dedendum $= \frac{0.94248}{D.P.}$ or $0.3 \times C.P.$
7. Total depth $= \frac{1.72788}{D.P.}$ or $0.55 \times C.P.$

in which

N = number of teeth;
$D.P.$ = diametral pitch;
$C.P.$ = circular pitch; and
$P.D.$ = pitch diameter.

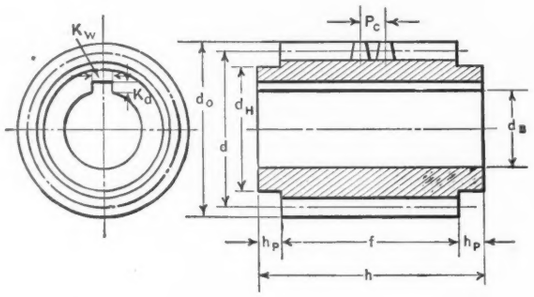
The outside diameter equals the pitch diameter plus the tooth thickness at the pitch line.

Standards for Worm-gearing

The committee on worm-gearing presented a report which was adopted as recommended practice. The tables herewith embody the standard recommended. This standard represents an endeavor to combine in a commercial, practical and scientific manner those elements of design and manufacture that effect the efficient performance of worm-gearing in ordinary industrial service.

STANDARD WORMS

(Recommended Practice of the American Gear Manufacturers' Association for General Industrial Uses)



Terms	Symbols	Single and Double Thread	Triple and Quadruple Thread
Circular pitch	P_c		
Pitch diameter	d	$2.4\ P_c + 1.1$	$2.4\ P_c + 1.1$
Outside diameter	d_o	$3.036\ P_c + 1.1$	$2.937\ P_c + 1.1$
Root diameter	d_r	$1.667\ P_c + 1.1$	$1.741\ P_c + 1.1$
Hub diameter	d_H	$1.667\ P_c + 1$	$1.741\ P_c + 1$
Bore diameter (max.)	d_B	$1.75\ \sqrt{P_c}$	$1.75\ \sqrt{P_c}$
Face length	f	$P_c\left(4.5 + \frac{N}{50}\right)$	$P_c\left(4.5 + \frac{N}{50}\right)$
Hub projections	h_p	P_c	P_c
Hub length	h	$f + 2\ P_c$	$f + 2\ P_c$
Keyway width	K_w	A. G. M. A. Standard	A. G. M. A. Standard
Keyway depth	K_d	A. G. M. A. Standard	A. G. M. A. Standard
Addendum	a	$0.3183\ P_c$	$0.2865\ P_c$
Normal thickness	t	$0.5\ P_c \cos \theta$	$0.5\ P_c \cos \theta$
Whole depth of tooth	t_d	$0.6866\ P_c$	$0.6179\ P_c$
Angle of thread	θ	$\cot = \frac{d\pi}{\text{lead}}$	$\cot = \frac{d\pi}{\text{lead}}$

Machinery

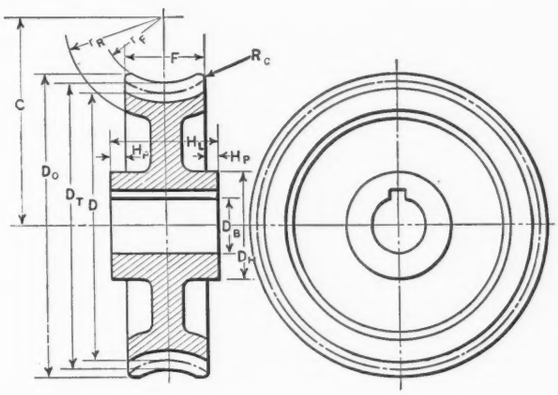
In studying the problem of standardization of worm-gearing, it was found advisable to divide the gearing into groups, and the group covered by the present recommendations may be defined as follows: Linear pitch ¼ to 2 inches; single to quadruple threads; gear ratios from 10 to 1, to 100 to 1.

The group thus defined includes worm-gearing demanded by the trade for general commercial uses, where the gearing is furnished without bearings or housings and does not include shaft worms, smaller or larger pitches than those mentioned, worms having more than four threads, gear ratios greater or less than those specified, gearing with the axis other than 90 degrees, or where the duty required or quantity involved justifies a further refinement of design than that used in the case of these general-purpose worms and gears.

In conjunction with the proportions recommended, it is also advised that (1) the thread form to be regarded as standard will be the form produced by a straight-sided milling cutter having a diameter not less than the outside diameter of the worm, nor greater than 1.25 times the outside diameter of the worm, the sides of the cutter having an angle of obliquity of 14½ degrees in the case of single- and double-thread worms, and an angle of obliquity of 20 degrees in the case of triple- and quadruple-thread worms; (2) single- and double-thread hobs may be fluted parallel to the axis; (3) triple- and quadruple-thread hobs should be fluted normal to the thread angle reckoned from the outside diameter of the hob; (4) the following linear pitches are to be regarded as standard for this group: ¼, 5/16, ⅜, ½, ⅝, ¾, 1, 1¼, 1½, 1¾, and 2 inches. Worms of these linear pitches having one, two, three and four threads give a series of 44 worms from which it is thought gearing for any ordinary service can be selected.

STANDARD WORM-GEARS

(Recommended Practice of the American Gear Manufacturers' Association for General Industrial Uses)



Terms	Symbols	Single and Double Thread	Triple and Quadruple Thread
Number of teeth	N		
Circular pitch	P_c		
Pitch diameter	D	N × 0.3183 P_c	N × 0.3183 P_c
Throat diameter	D_T	D + 0.6366 P_c	D + 0.573 P_c
Outside diameter	D_o	D_T + 0.4775 P_c	D_T + 0.3183 P_c
Hub diameter	D_H	1.875 D_B	1.875 D_B
Min. bore diameter	mD_B		
Keyway	Ky	A. G. M. A. Standard	A. G. M. A. Standard
Hub length	H_L	1.5 D_B	1.5 D_B
Face	F	2.38 P_c + 0.25	2.15 P_c + 0.2
Hub projections	H_P	¼ D_B	¼ D_B
Radius of face	r_F	0.8817 P_c + 0.55	0.9135 P_c + 0.55
Radius of rim	r_R	2.2 P_c + 0.55	2.1 P_c + 0.55
Center distance	C	(D + d) 0.5	(D + d) 0.5
Radius at edge of face	R_e	¼ P_c	¼ P_c

Machinery

Recommendations for Hobs during Transition Period

The fact is recognized that in the case of worm-gearing a longer period of transition from present haphazard methods of designing to standard methods may be expected, and in order that the best results may be obtained from existing facilities, the following recommendations are made for the use of existing hobs:

Face of Wheel—For wheels engaging with single- and double-thread worms, the width of the face should not be greater than the chord of the worm outside circle which is tangent to the worm pitch circle, plus one-half the linear pitch.

For wheels engaging with worms having triple and quadruple threads, a face width of one-fourth the linear pitch less than the above is recommended.

Outside Diameters—For the use of existing hobs it is recommended that the outside diameter of worm-gears be made the following amounts larger than the pitch diameter:

For wheels meshing with single- and double-thread worms,

$$D_o = D + 3.5a$$

For wheels meshing with triple- and quadruple-thread worms, where the pressure angle is 20 degrees or greater,

$$D_o = D + 3a$$

For wheels meshing with triple- and quadruple-thread worms, where the pressure angle is less than 20 degrees,

$$D_o = D + 2.75a$$

In the foregoing formulas,

D_o = outside diameter of worm-wheel;
D = pitch diameter of worm-wheel; and
a = distance from pitch circle to root of gear tooth.

Radius at Edge of Rim—In every case a radius at the edge of the wheel rim equivalent to one-fourth the linear pitch is recommended.

* * *

STANDARD HOSE COUPLING THREADS

The importance of standardization of hose coupling threads is not fully appreciated, either by engineers, manufacturers, or the general public. Only 25 per cent of the American cities are now using standard equipment. Standard hose coupling threads would sometimes save millions of dollars in property losses from fire, as it would permit communities to aid each other in the cases of serious conflagrations. It has been pointed out, for example, that the fire-hose couplings used in New York City, Baltimore, and Washington, are not interchangeable with one another, yet they could be made completely interchangeable by the simple operation of rethreading with standard threading tools.

The use of different threads on fire-hose couplings prevents communities from helping each other in case of serious fires. Thus, in the great Baltimore fire, the fire-fighting equipment brought from Washington and Philadelphia was useless because it could not be connected to the Baltimore hydrants. In the San Francisco fire, the city's water supply had been cut off by the earthquake. There were warships in the harbor with powerful pumps that could have helped in fighting the fire but for the fact that their coupling threads did not fit the threads on the city's hose couplings. In both of these cases property to the value of many millions of dollars could have been saved if the threads on the hose couplings had been standardized. In a great many cases rethreading tools make it easy and inexpensive to change the equipment to standard. Couplings can be rethreaded at a moderate cost, and new equipment of standard dimensions can be purchased as the old equipment wears out. Those interested in this subject should communicate with the Bureau of Standards of the Department of Commerce, Washington, D. C.

* * *

The annual destruction of property due to fires caused by lightning in the United States is approximately $20,000,000. The Weather Bureau of the U. S. Department of Agriculture points out that nearly all of this loss could be prevented by proper application of lightning conductors.

CUTTING DIEMAKING COSTS

By T. A. SCHAAD

The diemaker's wages are usually the chief item in the cost of a die. As the diemaker is generally paid by the hour; the greater the amount of work he produces per hour the lower will be the cost of the die. Often it is possible to increase the production of a workman by devising a method that will enable him to perform his work faster, better, and more accurately without making it half as painstaking. It is with this in view that the method described in this article was developed.

The general practice in the making of blanking, piercing, and shaving punches is as follows: The punch is first machined, the outline of the blank then scribed on the face, the punch end-milled to within 1/64 inch of the line, and then hand-filed to within 0.003 or 0.004 inch of the line. Next it is pressed into the die to obtain an impression, after which it is again hand-filed closer to the impression. The punch is then sheared and fitted in the die by hand-filing, the distance fitted generally being ⅞ inch, although it is sometimes 1½ inches, which makes the fitting a tedious operation.

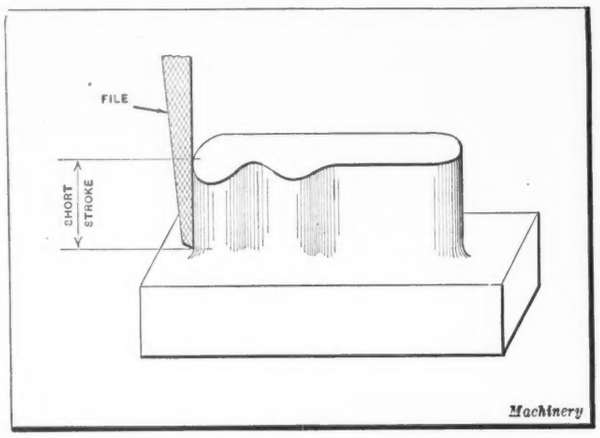


Fig. 1. Method of hand-filing a Punch

The punch is next hand-filed under size for break clearance. As much as 0.010 inch is sometimes filed off, depending on the thickness of the stock to be blanked. After the punch is hardened, it is often found that the proper amount of clearance has not been provided for, so that it is necessary to stone it down thus making the operation slow, difficult, and extremely expensive.

A punch of the usual design is shown in Fig. 1. In finishing a punch of this kind, the hand-filing is done with the extreme end of the file, a very short stroke being used. The filing of a flat and square surface by this method is difficult, slow, and costly. Furthermore, the filing of the break clearance, in places where measuring instruments cannot be employed, is but guesswork and most diemakers leave more stock than is required, so that much stoning is necessary.

This painstaking and expensive method can be eliminated by the use of rotary files. Fig. 2 illustrates the method of using rotary files. The file is held in a high-speed drill press chuck, and the punch is brought to bear against it with a gentle pressure. The action is practically the same as in end-milling. The rotary file can also be used for filing dies, templets, gages, etc., and wherever hand-filing can be easily and economically superseded. It will be noticed that the outline traced on the face of the punch is always visible.

In Fig. 3 is shown a clearance rotary file. The shank of the file is smaller in diameter than the body by the same amount as the break on the punch. The new and more efficient procedure in making a blanking punch is as follows: After the punch has been rough end-milled, a regular rotary file is used to file to within 0.003 or 0.004 inch of the line, and the punch is sheared in about ⅛ inch. Then a clearance rotary file is held in the chuck so the shank will contact with the work as the file mills away the stock, and act as a guide against the sheared part of the punch at *A*.

It is evident that it is impossible to file too much off the punch; furthermore, the amount is everywhere the same as it should be for the break, and a well made file will mill away infinitely more than a hand file in the same time, so that the time required for fitting is reduced to a minimum. Of course sharp fillets cannot be reached by the round file even though its diameter is small, but the saving made where it can be used makes it a worthwhile tool to employ.

Rotary files such as required when the methods described are employed can be made in many different ways. They can, of course, be cut by hand or milled. A good grade of steel that will keep straight and not become too brittle nor too soft should be used. The writer has used files of this kind for a great many years.

* * *

Statistics published by the Department of Commerce show that during the fiscal year 1921-1922 Australia imported machinery and other manufactures of metal to a value of over $100,000,000. In this total were included machines for all purposes to a value of about $35,000,000. Small tools were imported to a value of over $3,000,000, and automobiles and parts to a value of over $18,000,000.

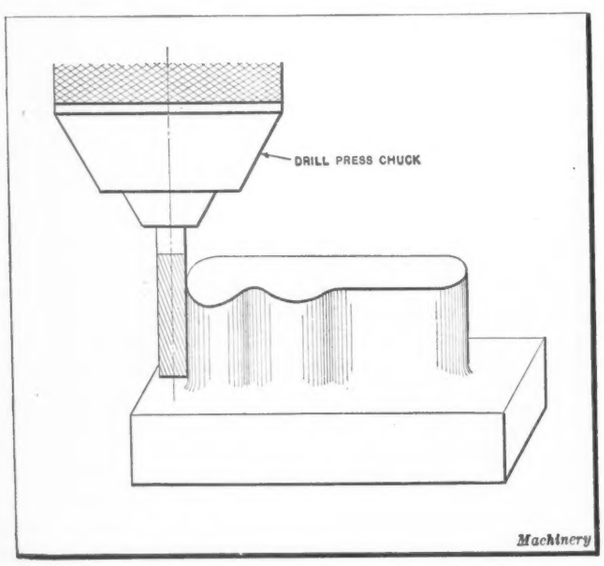


Fig. 2. Filing a Punch with a Rotary File

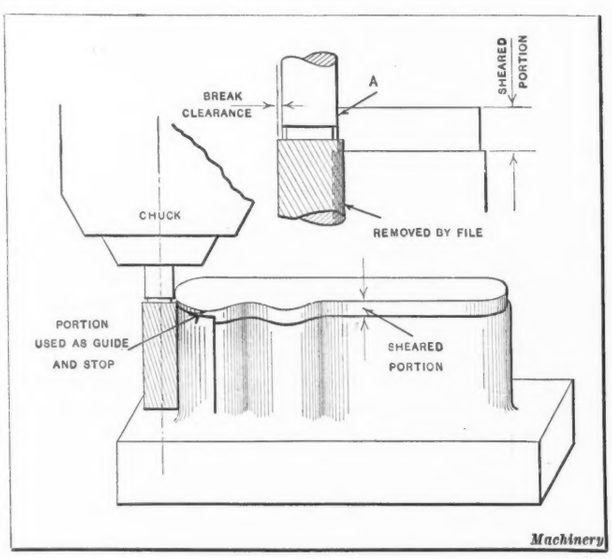


Fig. 3. Using Sheared Part of Punch as a Guide for Rotary File

Letters on Practical Subjects

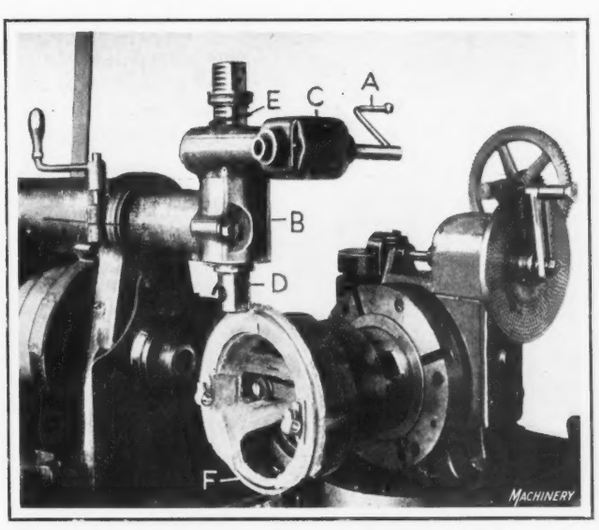
UNIVERSAL GRADUATING FIXTURE

The milling machine, in conjunction with the dividing head, is customarily used for graduating operations that are not provided for by special fixtures. Especially is this true of new parts which have not become standardized. However, the milling machine cannot be considered an ideal tool for this kind of work, as it is rather cumbersome and its manipulation is considered a laborious task by most workmen.

Realizing this, the writer improvised a graduated fixture from some standard parts that happened to be available, and applied them to the overhead arm of a milling machine, as shown in the accompanying illustration. The fixture, from the fact of its being thus mounted, is of universal application. It is suitable for either flat, cylindrical, internal, or external work, and can be set at any angular position. Instead of moving the work, the cutter is fed against the surface to be graduated by means of the handle *A*.

The principal parts of a thread-chasing attachment regularly supplied with a well-known turret lathe were used in the construction of the fixture. Briefly, they consist of base *B*, which is bolted to the overhead arm of the milling machine; head *C*, which has a cylindrical shank supported in the upright part of the base; ram *D* with rack teeth cut on one of its sides which mesh with a spur gear (not shown) on the end of the shaft within the vertical or upright part of the base *B*, and which is manipulated by means of the lever or crank-handle *A*. A pair of miter gears within the head transmit motion through the shaft from the lever *A*.

The cutter is held in a dovetail at the end of the ram *D* by a set-screw. A 1-inch hole is drilled through the ram at a point just back of the cutter to permit the operator to watch the action. Step blocks are attached to the housing, and the collars are set so that the stroke is properly controlled for producing different lengths of graduation lines on either the up or down stroke of the cutter. The coil spring *E*, located between the collar and the housing, serves to return the ram to its normal position after a cutting stroke. The work *F* which is being graduated is the hour circle of a garden telescope.



Universal Graduating Fixture made up from Standard Machine Parts

Springfield, Vt. O. S. MARSHALL

COMPOUND AND DIFFERENTIAL INDEXING

The writer believes that the methods described in this article for determining the movements for compound and differential indexing will prove of value to many readers of MACHINERY. To illustrate the application of the method of compound indexing, let it be required to find the movements necessary to index a piece of work 1/69 revolution.

First resolve into its factors the number of divisions required, namely, $3 \times 23 = 69$. Now place the multiples of these factors in two lines. Thus we have the multiples of $3 = 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33$, etc., and the multiples of $23 = 23, 46, 69, 92$, etc. Now select two numbers, one from the multiples of 3 and the other from the multiples of 23, whose sum or difference is equal to 40 (40 being the ratio of the dividing head). Thus we have the following combinations of figures to choose from:

$46 - 6 = 40$, $63 - 23 = 40$, $4 \times (33 - 23) = 40$, etc.

Now

$$\frac{46}{69} - \frac{6}{69} = \frac{2}{3} - \frac{2}{23}$$ which also equals $\frac{40}{69}$

Indexing circles are next selected which are divisible by these new denominators. To obtain the required index movement of 1/69 revolution, the crank is moved forward 2/3 of a revolution. Now without disengaging the index-pin from the plate a backward movement of 2/23 revolution of the index-plate is made. The combined movements will result in rotating the worm-shaft 40/69 revolution, which is the movement required to index the work-spindle 1/69 revolution.

As an example of differential indexing, let it be required to find what circle of holes in the index-plate and what gearing is required to obtain 59 divisions. The number of holes in the index circle selected must not be 10 per cent greater or less than the number of required divisions and

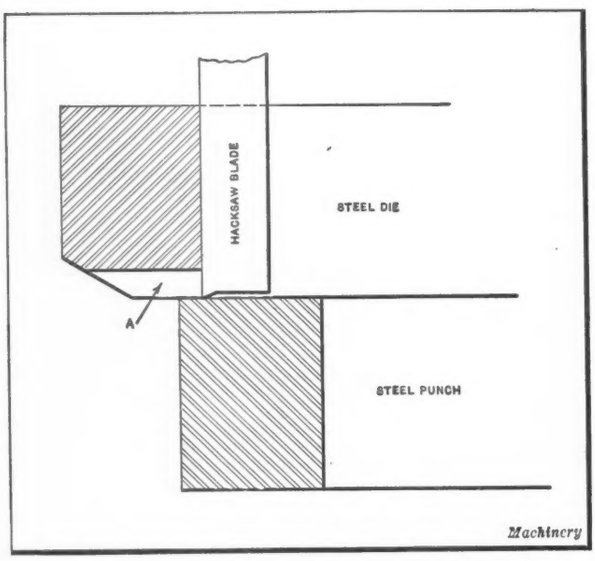


Fig. 1. Method of scribing Blanking Punch Profile

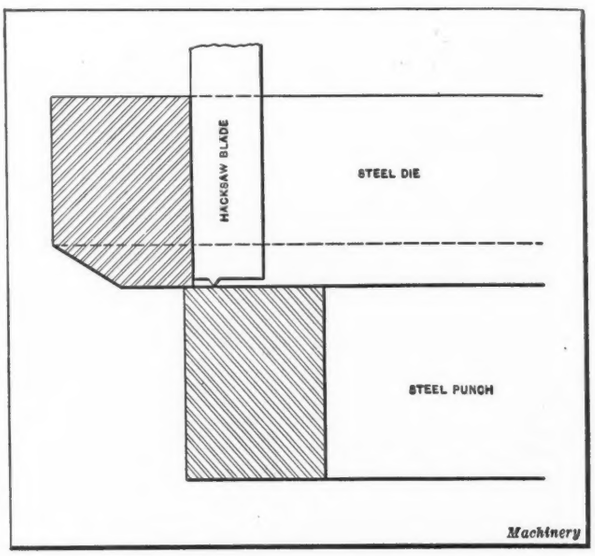


Fig. 2. Method of scribing Outline of Drawing Punch

must be capable of simple indexing. Now all the numbers between 53 and 65 are not 10 per cent greater or less than the required number of divisions. Also the numbers 54, 55, 56, 58, 60, 62, and 64 are capable of simple indexing. Circles of 54, 55, 56, 60, and 64 holes are available and fulfill the two requirements previously mentioned. Now, selecting an index circle of 60 holes, the sector is set at 40/60 or 2/3 of a revolution. If 59 movements of 40/60 revolution of the indexing crank are made, the crank would make a total of 39 1/3 revolutions which is 2/3 revolution less than the 40 revolutions required to rotate the work-spindle one complete revolution. Therefore, while the work revolves once, the index-plate must be made to turn in the same direction as the crank through 2/3 revolution. The ratio of the gearing between the work-spindle and the index-plate must therefore be as 2 is to 3. Thus we could obtain the required results by placing a gear having 32 teeth on the work-spindle and a gear having 48 teeth on the index-plate. The following formulas are useful in selecting the gears for differential indexing. In these formulas let

R = number of turns of indexing crank required to give one revolution of the work = 40;

C = number of teeth in gear selected for index-plate; and

D = number of divisions required on work.

$$\text{Thus we have, ratio of gearing} = R - \left(\frac{40}{C} \times D\right)$$

or

$$(C - D) \times \frac{R}{C} = \text{ratio of gearing} = \frac{\text{Number of teeth in gear on work-spindle}}{\text{Number of teeth in index-plate gear}}$$

The setting for the sector equals $R \div C$. If the answer obtained by the use of the preceding formula is plus, both the crank and the index-plate will rotate in the same direction, but if the answer is minus, the crank and index-plate must turn in opposite directions. The methods of indexing described in this article have been employed by the writer in his work as instructor at the Sydney Technical College.

A. W. Pople

Croydon, New South Wales, Australia

HACKSAW BLADES FOR SCRIBING PUNCH PROFILES

A method of using old hacksaw blades for scribing the profiles on blanking and forming punches is illustrated in Figs. 1 and 2. It will be noted that the inverted dies are placed on the end surfaces of the punches, so that the sides of the die openings serve to guide the hacksaw scribing blade. The blade used for scribing the blanking punch profile has the scribing point in line with the edge that is held against the sides of the die opening, as shown in Fig. 1.

The scribing point on the blade used for the forming punch is located back from the edge from 1/32 to 3/16 inch, the amount depending on the thickness of the stock to be drawn. The edge of the drawing die, which is shown sharp in Fig. 2, is, of course, rounded before being put into use. The unsectioned space at *A*, Fig. 1, represents a serration or groove on the face of the die, which would prevent the satisfactory use of an ordinary scriber in place of the hacksaw blade.

Ypsilanti, Mich. Floyd Graves

STOCK LOCATING AND STRIPPING DEVICES FOR PRESS DIES

A simple three-pin locating gage constructed as shown in Fig. 1 is satisfactory when only a few thousand pieces are to be made in a die. Usually when more than 10,000 pieces are required, the table shown in the upper view of Fig. 2 will be found more economical, as it makes possible continuous operation of the punch. The die table is made of two pieces of angle-iron to which is riveted a steel plate *A*. An opening is cut in this plate so that its top surface may be located flush with the face of the die. A stripper plate *C* is fastened to the guide bars *B*. The usual stop-pin *D* projects through a small opening in the steel plate *A* which forms the top of the die table. As there is nothing but the stop-pin to obstruct the stock as it is fed forward, the operator can sometimes keep the press in continuous operation at a speed as high as 125 strokes per minute.

In punching lithographed tin, which is made wide enough for four or more rows of blanks, it is necessary to

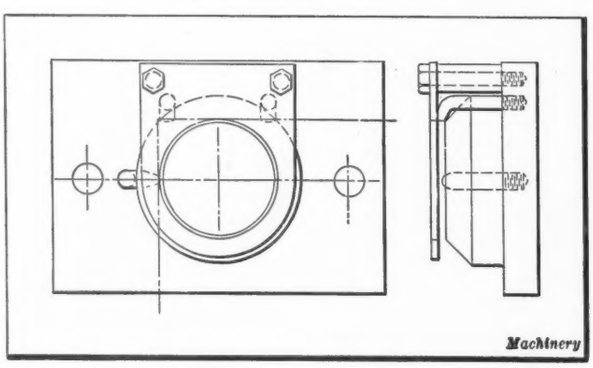


Fig. 1. Blanking Die provided with Simple Stock Locating Pins

provide two or more rows of back gages. In such cases a table like the one shown in the lower view of Fig. 2 is required. On decorated tin, care must be taken to make sure that the stock is located so that the design will be concentric with the blanked pieces. As a stripper plate like the one shown in the upper view of Fig. 2 would hide the design on the lithographed stock, a spring-actuated stripper, such as shown in Fig. 3, should be used. This consists of a ring *A* which is held flush with the cutting edge of the punch by the angle-pieces *B*. These bars are a sliding fit between two guides attached to the sides of the press slide. The cross-bars at the top of the slide limit the downward travel of the stripper.

This style of stripper is especially well adapted for use on combination blanking and deep drawing work, as the springs can be made quite long in proportion to the distance through which the stripper ring travels. While it is the practice to incline the press so that the work falls out of the punch clear of the die, an expert operator can sometimes operate the press at such a fast speed that the force of gravity cannot be depended upon to take the punchings clear from the die before the punch descends. In such cases an air pipe *C* with an opening in its lower end is secured to the frame of the press. This pipe is so located that the air blast from it will cause the blanked and formed part to be sent down the chute before the punch can catch or jam it against the stripper plate or die.

When the stock has staggered rows of decorative designs, it is necessary to provide two locating stops. The stock is usually trimmed so that the stationary gage will locate it properly for the first blank. The first blank on the second row being staggered must, of course, be located by another stop-pin or gage-pin such as shown at *E*, Fig. 2. This stop is used only for the first hole of each alternate row, the stationary stop *F* being used the rest of the time.

Brooklyn, N. Y. S. A. McDONALD

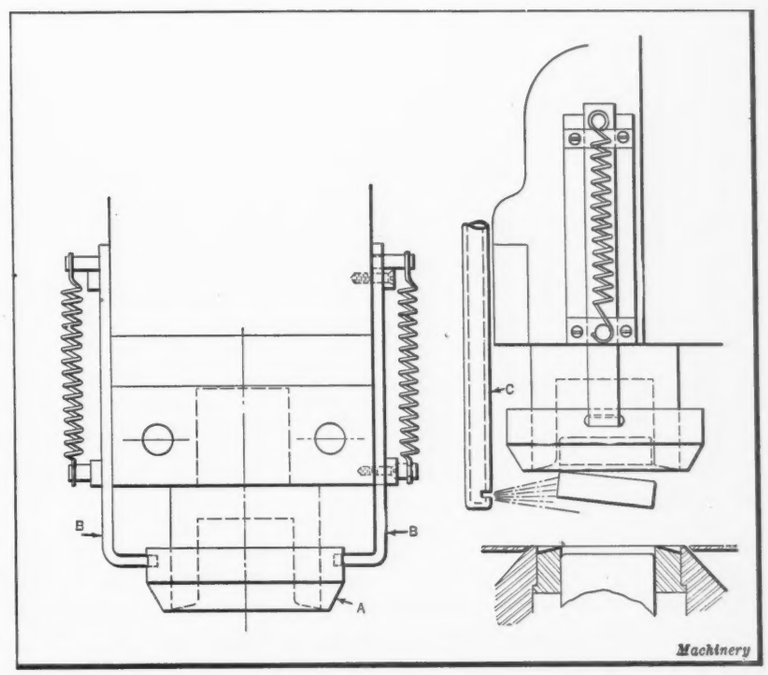


Fig. 3. Stripper used in blanking Lithographed Stock

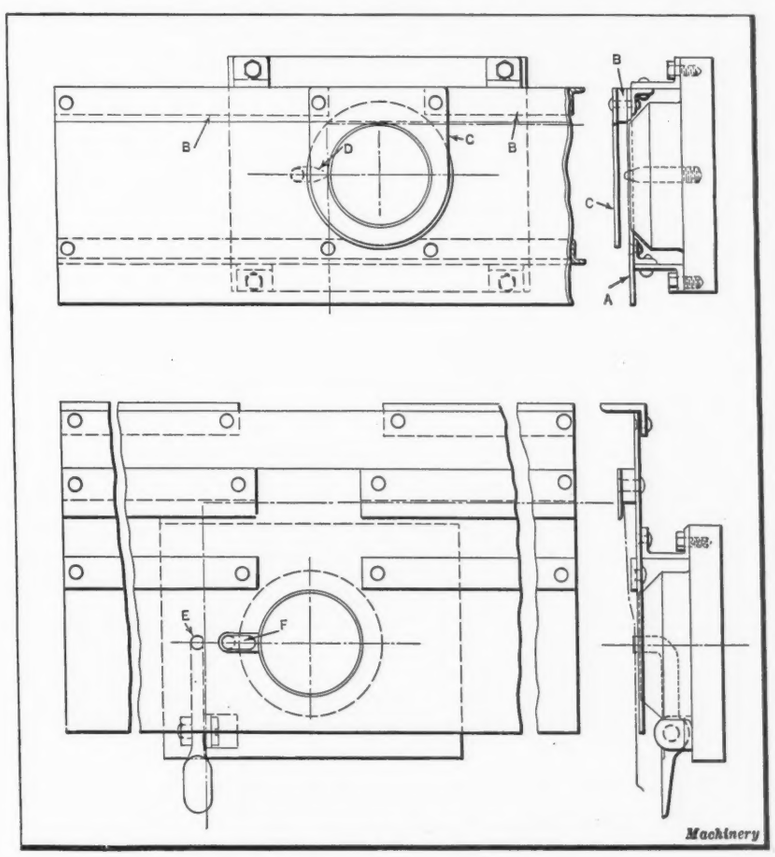


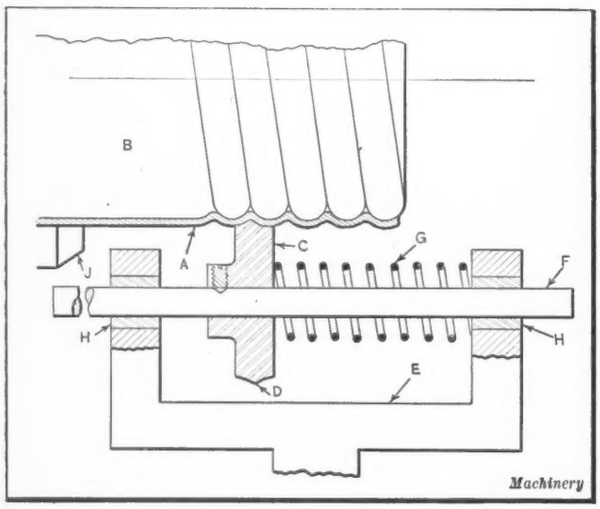
Fig. 2. Blanking Dies equipped with Work-supporting Tables

ROLLING THREADS ON THIN TUBES

A tool designed for rolling threads on seamless brass tubing is shown diagrammatically in the accompanying illustration. This special rolling tool is employed on a No. 2 Brown & Sharpe hand screw machine. The shell or tubing *A* on which the thread is rolled has a wall thickness of 0.015 inch and a diameter of 9/16 inch. The thread to be rolled is right-hand, the spindle being rotated in the opposite direction from that in which it is ordinarily run. The end of the tubing that is thus threaded serves as a socket for the end of a coil spring which is screwed into the tubing after the thread has been rolled.

The arbor *B* is made 0.005 inch smaller than the inside diameter of the work to allow for variations in the diameter of the tubing. The diameter of the large or outside roller *C* is three times that of the mandrel *B*, although in the illustration the work is shown to a greatly enlarged scale. The edge of the roller is slightly rounded at *D* to prevent the tubing from being cut. A little experimenting was required at first in order to determine the correct form for the roll *C*. After the correct form had been determined, a templet was made for use in making up new rollers.

The mandrel *B* is set into the end of a piece of round stock, which is slipped through the machine spindle and fastened to it at one end. The mandrel projects, of course, through the collet jaws. The work is placed over this mandrel and pushed back under the collet jaws *J* until it is stopped by the end of the round stock in which the mandrel is set. The collet jaws can then



Device used in rolling Threads on Thin Shells

be tightened on the work to secure it to the mandrel. The holder *E* is fastened in the toolpost on the cross-slide of the machine with its shaft *F* parallel to the mandrel *B*.

Roller *C* travels with mandrel *B* against the action of spring *G* when forming the thread. After the thread has been rolled, spring *G* returns the roller to the starting point. The work is removed by releasing collet jaws *J* and holding on to work *A*. As this is a right-hand thread, and the machine is revolving backward, only the collet jaws need be released to remove the work. If the stop on the cross-slide is properly set, the work can be easily unscrewed. The mandrel and the roller must be free from tool marks, as otherwise, considerably difficulty may be experienced in removing the work. An ordinary 60-degree V-point tool is used to cut the thread on the mandrel *B*. The flat left at the top of the thread must, of course, be wide enough to permit the corners to be rounded to the required radius. The shaft *F* on which the roller *C* is fastened is a sliding fit in the two hardened bearings *H* which are pressed into the holder *E*.

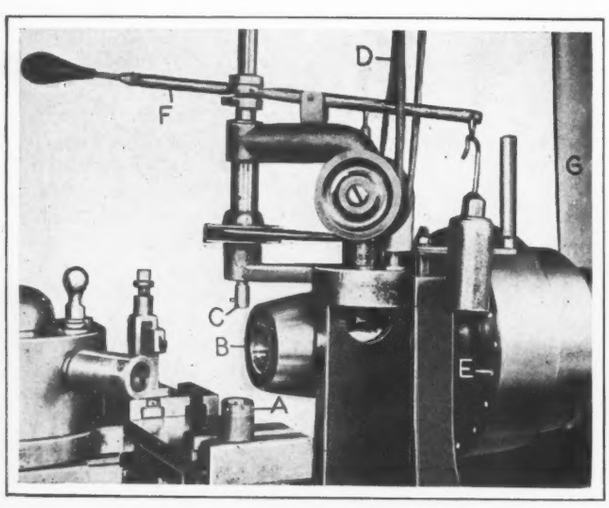
Indianapolis, Ind. FRED O. HEINZ

LATHE ATTACHMENT FOR DRILLING CROSS-HOLES IN COLLARS

A rather novel use for a turret lathe is shown in the accompanying illustration. This set-up is used for drilling eight 0.156-inch holes in collars like the one shown at *A*. The collar is held in the lathe chuck *B* in the usual manner, and a drill of the required size is placed in the chuck *C* of the special attachment. The chuck is revolved by means of the belt *D* through the medium of an overhead countershaft. At the front side of the machine there is an index-pin which can be inserted in holes *E* in the face of the stepped pulley to obtain the required spacing of the cross-holes in the work.

In operation, the piece is first placed in the chuck or collet *B*, after which the drill in chuck *C* is fed down through the work by exerting a downward pressure on the handle *F*. After the hole is drilled through the work, handle *F* is allowed to return to its normal position, and the piece is indexed to the next station, the indexing and drilling operations being repeated until the desired number of holes have been drilled in the collar. The driving belt *G* of the machine is, of course, disconnected during the drilling operation.

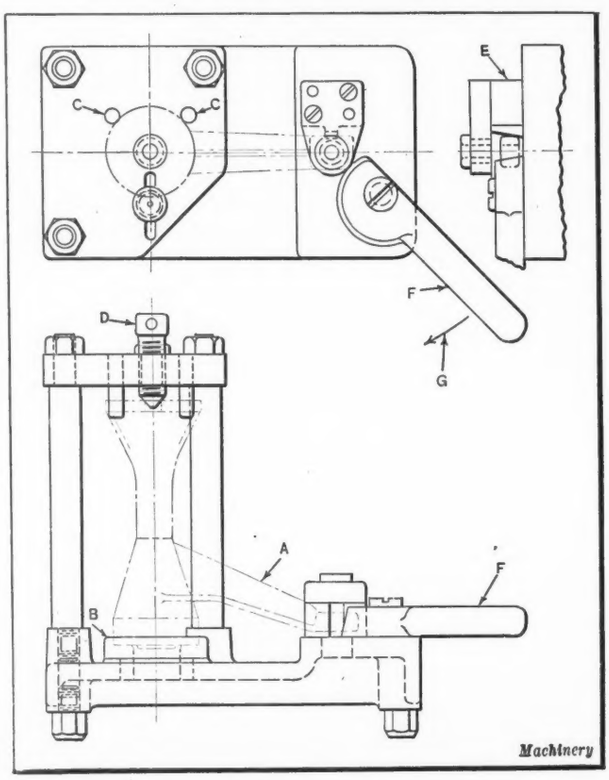
Providence, R. I. ROBERT MAWSON



Set-up for drilling Cross-holes in Collars

DRILL JIG FOR PART HAVING AN OVERHANGING ARM

Nearly all tool designers have at one time or another been confronted with the problem of building a drill jig that required some special means of supporting an overhanging arm. A method employed in one case of this kind, which proved very satisfactory, is shown in the accompanying illustration. The work, indicated by dot-and-dash lines, has an overhanging arm *A* which is required to have a hole drilled through the boss at its outer end.



Drill Jig used in drilling Boss of Overhanging Arm

The body of the work is first secured in a vertical position by means of the cup bushing *B*, locating pins *C*, and clamp-screw *D*. The arm of the work rests against the side of block *E*, which locates it laterally. There is a clearance space under the arm to allow for any variation in the castings. The arm is locked in the position shown by a movement of cam-lever *F* in the direction shown by arrow *G*.

It will be noted that block *E* and cam *F* have tapered faces. The taper has an included angle of 20 degrees, which provides sufficient supporting surface to resist effectively the downward thrust of the drill. This type of support can be operated quickly, as only one movement is required to secure the work both laterally and vertically.

Eastwood, N. Y. ELMER C. COOLEY

INSERTED-BLADE REAMER FOR HEAVY DUTY

A simple method of producing inserted-blade reamers ranging in size from 5 to 8½ inches is described in the following. Referring to the accompanying diagram, the core *C* of the reamer is turned to a size that will permit the cutters to extend beyond the clamping pieces *D* about ¼ inch. The clamping pieces are cut from a band *E*, which is in reality a cylindrical tube having a thickness *F* that will give more than a full-depth countersink for the flat-head screws *G* used to hold down the clamping pieces.

Part *E* is bored out to a good press fit on the core *C*. The number of inserted blades desired is then determined, and the positions of the slots marked out on the circumference of band *E*. The band is next drilled and countersunk for the fillister-head screws *G*, and the core is tapped out for the screws. The holes are drilled so that they come midway between the lay-out lines for the slots. The number of screws in each row depends on the length of the reamer. For reamers of average length, three screws are used, as indicated in the illustration.

After screws *G* are tightened securely in place, the slots are milled for the cutter blades. Each sector *D* of the band produced by milling the slots, and each division of the core

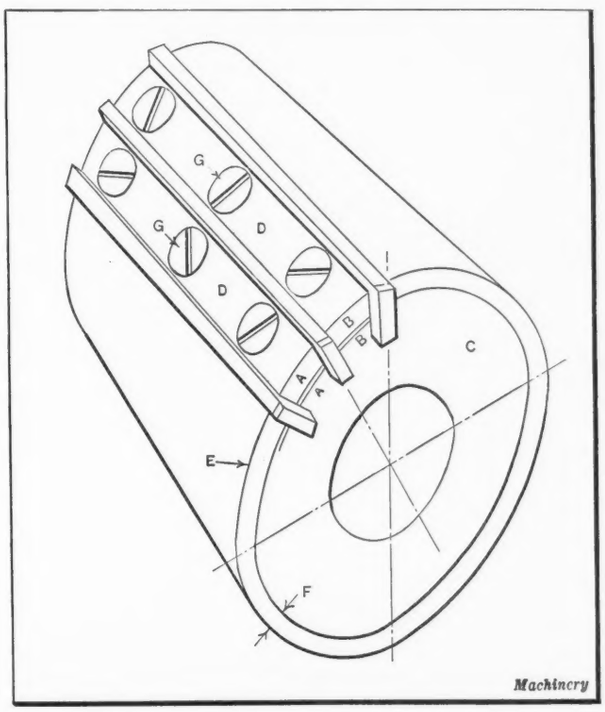


Diagram illustrating Method of producing Inserted-blade Reamers

are stamped as shown, so that the letter A on the sector corresponds with the letter A on the core. Next, the screws *G* are removed, and the core *C* turned down about 1/32 inch. to obtain the required clamping action.

The blades are then inserted and the sectors *D* fastened in their correct positions, as indicated by the letters stamped on the parts. To resharpen the reamer, shims are placed under the blades, after which the sectors *D* are clamped in place and the blades ground to size.

Evansville, Ind. F. SPRINGER

DETACHABLE MOTOR FOR DRIVING MACHINES DURING TESTS

In a plant engaged in the manufacture of electric and power washing machines, it was the practice to attach a motor to each machine, give the complete assembly a running test, and then remove the motor and send the separate units to the shipping departments to be crated. As con-

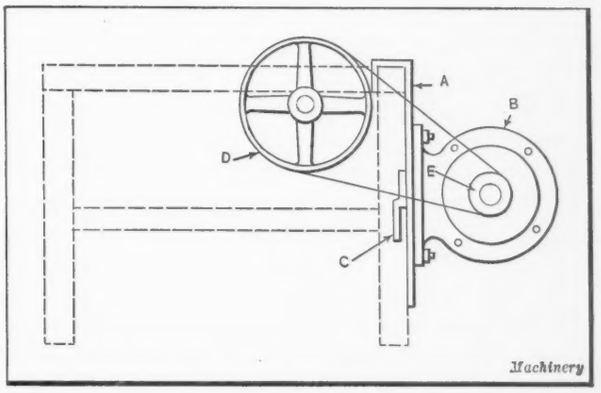


Diagram showing Method of attaching Test Motor to Machine

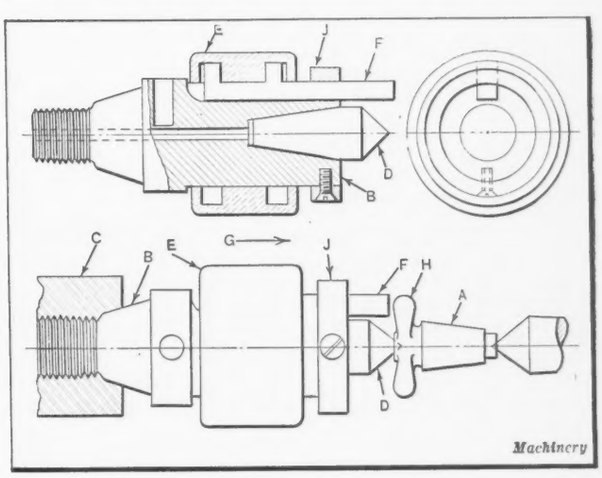
siderable time was required to attach and remove a motor, it was decided to provide a quicker means of making the test, which would not necessitate the insertion or removal of the regular hold-down bolts on the motor base. The result was a frame with a motor mounted on it, which could be hung on the end of the washing machine and used as the driving unit during the test. The frame was made from cold-rolled steel, ¼ inch thick by 1 inch wide. A good idea of the arrangement will be obtained from the illustration.

The frame *A* with the motor *B* mounted on it is hung on the washing machine—shown in dotted lines—by the hooked upper end of the frame. The cleat *C* is welded to frame *A* and slips over the lower braces on the washing machine cross-piece. After placing the motor and frame in position, a pulley *D* is temporarily placed on the driving shaft of the washing machine and belted to the driving pulley *E* of the motor. The extension cord or wire that supplies current to the motor is then connected to a lamp socket and the current turned on. After the running test has been completed, it requires only a few seconds time to remove the pulley *D* and lift the frame *A* and motor *B* from the machine, which is then ready to be sent to the shipping department.

Cicero, Ill. JOHN J. BORKENHAGEN

COMBINATION LATHE CENTER AND DRIVING DOG

In the accompanying illustration is shown a combination lathe center and work-driving dog designed to permit small pieces of work to be mounted on centers or removed without stopping the lathe spindle. The device, which has been patented by the writer, has proved particularly efficient for such turning operations as are required in machining brass keys or valves like the one shown at *A*, of which large quantities are required for shut-off cocks, for air, gas, and



Combination Lathe Center and Driving Dog

oil pipe systems. The device consists essentially of the following parts: A body *B*, threaded at one end to fit an adapter *C* which is screwed on the end of the lathe spindle; a center *D;* sleeve *E;* collar *J;* and a key or dog *F*. The construction is shown quite clearly by the illustration.

The method of using the device is as follows: After starting the lathe spindle, the operator picks up a piece of work *A* in his left hand, and places the centered end of the work in contact with the center *D*, as shown in the lower view of the illustration, after which the tailstock center is adjusted to support the other end of the work. By gripping the collar *E* in the left hand and sliding it in the direction indicated by the arrow at *G* the end of key *F* is extended until it comes in contact with one of the wings *H*. The key *F* then serves as a driving dog or pin. After the turning operation has been performed, the driving key *F* is withdrawn by simply sliding the collar *E* to the left. The work can then be grasped in the hand and removed as soon as the tailstock center is withdrawn.

Chemnitz, Germany TH. ROBERT WAGNER

SUB-PRESS AND PILLAR DIES

The term "sub-press" has come to be rather loosely applied in the metal-working industry when pillar tools or pillar dies are meant. The sub-press had its inception in this country in the clock industry, where it was first used about thirty-five or forty years ago as an efficient means for blanking out wheels and small gears for clocks and watches. Aside from its manner of use in the power press, the sub-press, as originally used, and the pillar tool employing posts to align the upper and lower members, are alike. Both operate on the same principle; both are used for similar classes of work; and both give the same degree of accuracy when properly used on the same kind of work.

As originally made, the sub-press was a miniature press with a solid arched cast-iron frame holding the lower die in the base. The upper die was fitted into the cylindrical part of the casting, directly over the center. This type of sub-

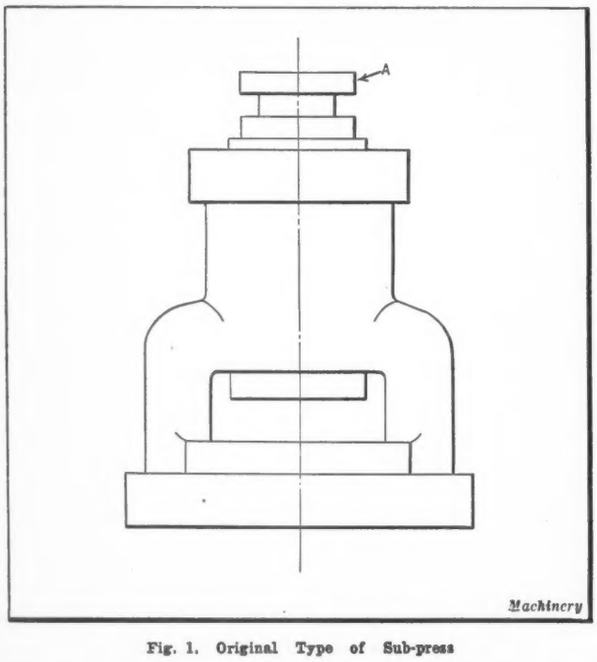


Fig. 1. Original Type of Sub-press

press is shown diagrammatically in Fig. 1. No pillars or posts were used in this design. The punch member, or upper die, has a button *A* for connecting it to the press, located centrally and shaped to fit a T-slotted punch-block, keyed into the dovetail slot of the press gate. This method of use is still employed in the clock industry.

The button of the sub-press is not fixed to the punch-block, but is engaged by the T-slot, in which it is permitted to float to adjust itself and maintain alignment of the tools. It is in this respect that pillar tools and sub-press tools differ. The sub-press is independent of the accuracy of the gate in the press ways, whereas the upper member of the pillar tool is keyed to the dovetail slot in the gate, without using a punch-block, and is thus affected by wear in the press ways, in so far as accuracy of alignment is concerned. Strictly speaking, the power press performs only one function when sub-presses are used, and that is to deliver power for actuating the dies.

Fig. 2. Later Development of Sub-press

The power press may be worn and out of repair, but the accuracy of the sub-press is not in any way affected. On the other hand, when pillar dies are used, any such condition will result in throwing the dies out of alignment or at least in causing the posts to become worn out of round, so that they first bind in the holes of the upper die-holder and then become a loose fit in them.

Starting with the clock manufacturers of Connecticut, the sub-press tool has increased in popular usage to the extent that tools operating on this principle are now used generally to blank out such stampings as motor disks and other similar flat work of an accurate nature. The term "sub-press" has been applied to this style of tool which, in reality, is a pillar tool in which the die members are not assembled into a solid frame but each die is carried in a separate frame and the alignment between the two obtained by the use of shrunk-in steel posts or pillars.

Fig. 2 shows a development of the solid-frame sub-press, which, although pillars are used to align the die members, is, strictly speaking, a sub-press, because it is not fixed to the gate but has a button for a floating connection in the punch-block. Usually two, three, or four of these posts are used. The so-called "sub-press" tools of this general appearance are in themselves capable of just as high a degree of accuracy as the original sub-press. However these tools are sometimes fixed to the press gate which defeats the purpose for which they were originally intended. In that case, everything depends on the accuracy of the press ways.

Waterbury, Conn. FRED R. DANIELS

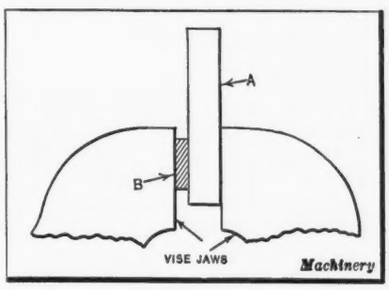
* * *

A survey of factories employing, in all, 250,000 workers indicates, according to D. W. K. Peacock of the White Motor Co., that straight piece-work is used in three-fourths of the plants and some form of bonus in one-third. Most plans involving an incentive are based on time studies, and are therefore confined to repetition work in shops engaged in quantity production. Consequently, in plants where the piece-work and bonus plan is generally in force, there are many workers who are paid on a straight time basis because their work is not of a repetitive nature.

Shop and Drafting-room Kinks

METHOD OF USING FILE FOR KNURLING

The accompanying illustration shows how an old file may be employed to knurl a round piece of work. One side of the file *B* is ground off smooth. The work *A* and the file are clamped between the jaws of a vise, as shown, so that the smooth side of the file is in contact with the vise jaw. The knurling operation is performed by simply driving the file endwise just far enough to allow the piece being knurled to make one complete revolution.



Using a File for a Knurling Operation

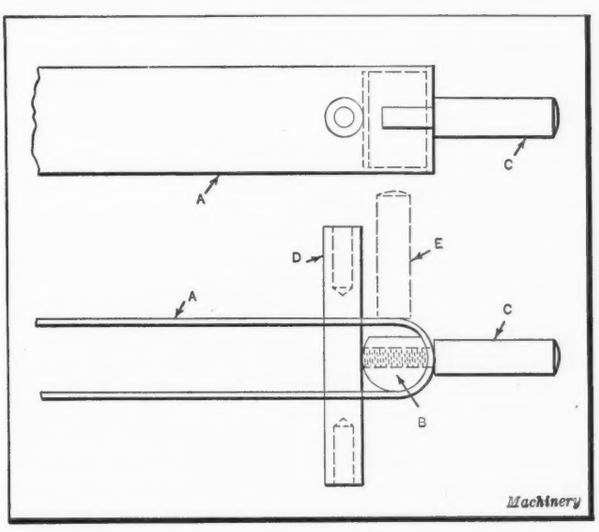
Ypsilanti, Mich. FLOYD GRAVES

QUICK-ACTING WORK-HOLDING CLAMP

A quick-acting holder or clamp for small round pieces that are required to have a hole drilled at each end is shown in the accompanying illustration. The drilling operation is performed on a sensitive drilling machine, with the work supported on a center at the lower end. The handle *A* of the holder is made from flat steel stock, bent around the steel piece *B* which has a flat milled on one side.

The lever *C* is threaded at one end to fit a tapped hole in part *B*. A hole is drilled and reamed through the handle *A* to receive the work *D*, and a slot is cut in the handle to permit the lever *C* to be moved to the upright position indicated by the dotted lines at *E*. When the device is in use, the work is slipped through both of the holes in holder *A*, and lever *C* is brought down to the position shown by the full lines. This movement of lever *C* causes the part to be held securely in place, but a tighter grip is obtained by pressing the sides of handle *A* together. To release the work, lever *C* is brought up to the vertical position so that the flat portion of part *B* clears the work.

Rosemount, Montreal, Canada HARRY MOORE



Clamp for holding Round Pins while drilling Hole in the Upper End

SPOT-WELDING SHEET-METAL PARTS

A large number of pieces of the outline shown at *A* in the illustration were required to be made. The piece is 9/32 inch wide at the widest point and 0.085 inch wide at the narrowest point, and has a thickness of 0.010 inch for its full length. As a die to punch the part in a single piece proved too expensive, as well as wasteful of material, it was decided to make the piece of two parts *B* and *C*, and weld them together electrically with a spot-welder. An increase in the thickness at any point was not allowable, so it was decided to cut out the wider part to receive the narrow part, as shown at *B*.

As a spot-welder was the only machine available, and as a butt weld on such thin material would probably prove unsuccessful, the following method was used: The cut-out on the end of the wider portion *C* was made to a width of 0.070 inch and a length of ¼ inch. The end of the narrow part was curled so that when placed in position it appeared as shown in the enlarged sectional view. It will be noted that the narrow part overlaps the cut-out by a few thousandths inch, which is sufficient to produce a lap weld along the sides. As the end of the narrow part does not overlap, no weld is produced at this point, but this did not prove objectionable.

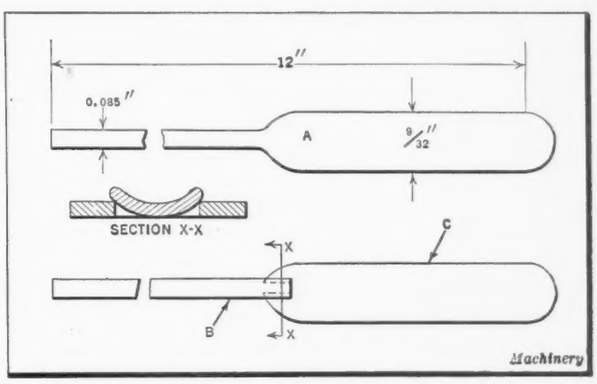


Diagram illustrating Method of Spot-welding Sheet-metal Parts

Philadelphia, Pa. R. H. KASPER

GUIDE LINES FOR LETTERING DRAWINGS

If a sheet of paper with properly spaced parallel lines is slipped under a tracing and so adjusted that the parallel lines can be used as guide lines when lettering in notes, a neat job can be done without drawing any guide lines on the tracing. A piece of heavy detail paper, about 6 by 16 inches, with parallel lines of various spacings drawn at right angles to each other and also diagonally across the sheet at an angle of 45 degrees, will be found very convenient for this purpose.

When a note is to be lettered in on a drawing, the paper is slipped under the tracing and lined up in the desired position, and all the lettering is done between the guide lines. By having a combination of lines at various angles, it is possible to slip the device under a tracing at any point without removing the thumb-tacks. The device also makes it comparatively easy to estimate the size and location of the note on the drawing.

Cleveland, Ohio EDWARD HELLER

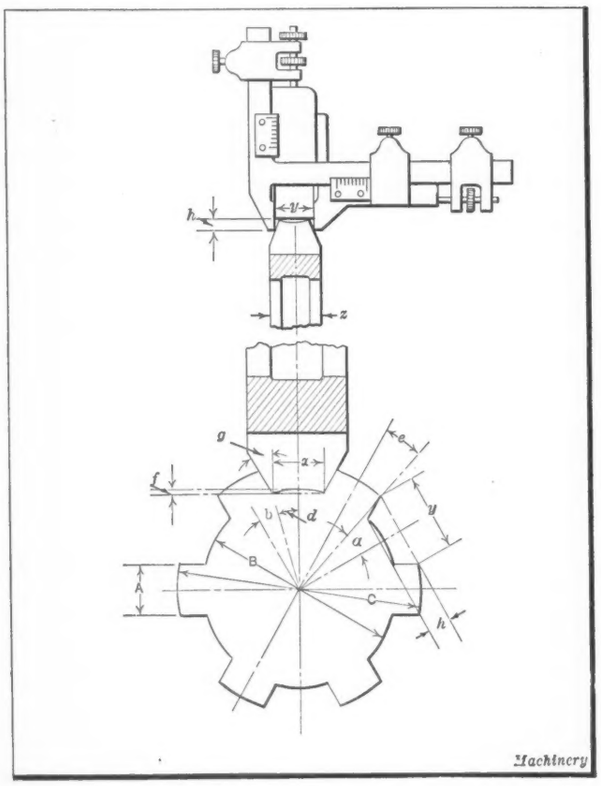
Questions and Answers

FORMULAS FOR DETERMINING DIMENSIONS OF A SPLINED SHAFT

H. B.—Formulas for calculating the various dimensions required for the inspection of splined shafts would be appreciated.

ANSWERED BY HARRY BURTON

The formulas given in the following have been used in calculating the various dimensions required in designing and inspecting splined shafts. Referring to the accompanying illustration we have given: N = number of splines, equally spaced on shaft; A = mean width of spline; B = mean small diameter of spline shaft; and C = mean outside diameter. It is required to find:



Diagrams used in calculating Dimensions of Splined Shaft

$$g = \frac{180}{N} \qquad \text{Sin } b = \frac{A}{B}$$

$$d = g - b \qquad x = B \sin d$$

$$f = \frac{B}{2}(1 - \cos d)$$

The height f is equal to the distance that the circular forming tool is fed radially toward the center of the cutter blank to obtain the width x. The thickness z indicated in the illustration may be determined by scaling a full-sized lay-out to obtain the dimension y and then adding about ⅛ inch. Cutters made by this method can be passed by the final inspector only after a test piece has been duly inspected. The most accurate and satisfactory method is to gage with what is termed a "gear caliper" such as shown in the upper half of the accompanying illustration. The dimensions required when this method of gaging is employed may be determined by the following formulas:

$$\text{Sin } e = \frac{A}{C} \qquad a = g - e \qquad y = C \sin a$$

When these formulas have been worked out, there remains only the caliper reading and the cutter thickness z to be obtained. For these dimensions we have:

$$h = \frac{1}{2}(C \cos a - B \cos d)$$

$$z = y + \frac{1}{8} \qquad B = \frac{x^2}{4f} + f$$

The last formula will be found convenient in checking the dimension x to prove the accuracy of dimension B, and is applicable to any problem where the diameter is required when the chord and height of the arc are given.

DRAFTING-ROOM SYSTEMS

R. B. T.—I would be interested in a brief outline describing a system for filing preliminary drawings and lay-outs in a machine building plant. If anyone has devised such a system, its publication in MACHINERY would probably prove of value to many readers.

ANSWERED BY R. KRAUS, WOODLAWN, PA.

Preliminary drawings and lay-outs should be made on sheets of standard size or folded to conform with some standard size used by the company. If traced, the next consecutive number is given to the tracing. When no tracing is made, the drawing is given an "X" number and filed in a different drawer from the one containing the regular drawings.

The drawings should be cross-indexed, that is they should be entered on the card index of the particular machine size for which they are intended, or a new card should be made out containing all the data pertaining to the machine if it is of an entirely new size or type. The various machine parts should also be indexed in the file containing index cards of similar parts. Some advantages are obtained by filing these cards with the standard index cards. However, some means should be provided for distinguishing them from the regular index cards. For instance, red ink may be used for making the notation on these cards in order to indicate that they represent only the preliminary or estimate drawings.

It is the practice of some companies to have separate files for the index cards of preliminary drawings and tracings, but this plan has the disadvantage that two files instead of one must be looked through when information is sought. If a preliminary drawing is finished so that it becomes a regular drawing, it is only necessary to make out regular index cards and destroy the old ones. If the preliminary drawing becomes entirely useless, it is marked off the drawing records and the index cards and the drawing are destroyed. The following three points should be remembered in developing any filing system:

1. A limitless number of drawing numbers are available and index cards are not expensive.

2. All index cards should be filled out without delay at the time when the drawing is completed and all necessary information is available or fresh in the mind of the draftsman.

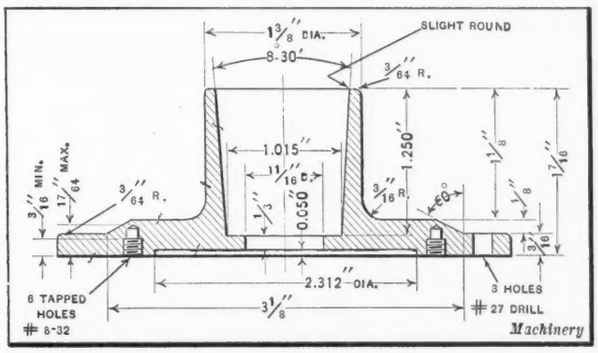
3. If a lay-out or preliminary drawing is not worth indexing, it should not be shelved but thrown immediately into the waste paper basket. Otherwise the office and vault will be hopelessly cluttered up in a short time.

TOOL DIVISION SYSTEM

L. H. T.—I am engaged in organizing a complete system for a tool division—a system that covers both the design and making of tools and their maintenance and repair. I am especially interested in systems used in shops engaged in quantity production and employing from 1000 to 2000 men. If someone who is familiar with such a system would outline it in detail, it would prove of great assistance to me.

WHAT WOULD BE A FAIR PRICE?

R. N. Y.—The accompanying illustration shows a part made from brass of which 3000 were to be machined all over, the castings being furnished to the contract shop for machining. Bids were asked for, and when they were opened, it was found that the prices quoted varied all the way from



16 to 80 cents per piece. This example indicates the great variation in cost estimates in different shops. Some readers of MACHINERY may be interested in estimating the cost per piece of machining a casting of this kind complete, including drilling and tapping the holes indicated. It will probably be conceded that 16 cents per piece is entirely too low a price, while 80 cents is rather high.

BUMPER DESIGN

N. R.—What is the customary practice in calculating the stress in a bumper that results from the impact of a moving body? The problem is encountered in designing mechanisms for various purposes, as, for instance, in designing a runway for a crank or a bumper for bringing billets to rest so that they may be transferred to a stack, and also in designing car bumpers and elevator safety devices. Starting with the general equation for kinetic energy $mv^2 \div 2$, we can deduct the amount of work that can be stored in the spring. After this is done, it is necessary to determine the stress imposed on the member that backs up the shock-absorbing spring. Any information regarding the design of bumpers such as outlined or reference to any publication on the subject of bumper design will be appreciated.

DOES A PATENT APPLICATION AFFORD ANY PROTECTION?

J. J. F.—I have filed an application for letters-patent on a mechanical device, and contend that I am as fully protected as though my patent were actually issued. A friend who has had considerable experience with patents informs me that an application for a patent affords no protection whatever and that protection is obtained only with the actual issuance of the patent. Which position is correct?

ANSWERED BY GLENN B. HARRIS, YONKERS, N. Y.

The advice of your friend is sound; an application for letters-patent affords no protection whatever against any other party making and selling the subject matter of the application. The application entitles you only to notice of the filing of an application for a patent on a construction similar to your own, in order that the question of inventorship may be determined by the Patent Office. Infringement can only take place from the day the patent is issued, and so anyone manufacturing the invention prior to the issuance of the patent would not be guilty of infringement. A user of the invention would not be liable for such use prior to the issuance of the patent, but if the user were given notice of the existence of a patent which it was claimed he was infringing, and continued such use after notice, he would be liable, provided the validity of the patent was sustained by the court after all proofs had been submitted. The court will in all cases sustain a patent where it is possible to do so, but many of the patents that are litigated are so loosely written, or so poorly prosecuted before the Patent Office, that the court is compelled to declare them invalid.

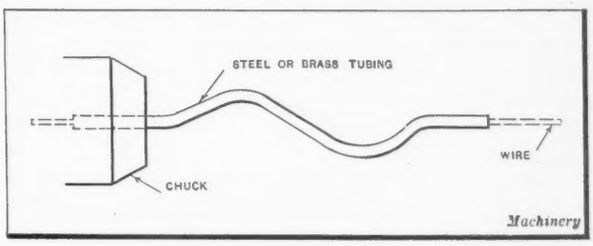
WIRE STRAIGHTENING

W. F.—I wish to know of a method for straightening fine-gage nickel-silver alloy wire 0.007 inch in diameter. The wire as supplied by the manufacturers is in the form of 8- to 10-inch coils, and when cut into lengths retains the curvature of the coil. As the wire is required in straight lengths, this has to be overcome. Whatever the method adopted for straightening the wire, it must not alter the temper nor hardness, for the metal must retain its springy nature. I also use highly tempered spring wire of the same gage. This, too, is supplied in coils of 8 to 10 inches in diameter, but when cut, it assumes straight lengths.

ANSWERED BY L. C. K.

The following method of straightening wire from the coil will be found effective up to about 3/32 inch diameter in brass and about 1/16 inch in steel. A piece of either steel or brass tubing is held in the spindle of a small lathe or polishing head, having a clear hole through the mandrel, and is formed with a double bend in wave form, as shown in the accompanying illustration. For wire of 0.007 inch diameter, a tube with a bore of about ⅛ inch diameter will be found suitable. The end of the coil of wire to be straightened is threaded through the spindle and bent tube, the protruding end gripped against turning, and the spindle started.

The wire is then pulled slowly through the revolving bent tube by the operator and fed through by another operator at the rear end of the spindle, the operators maintaining a tension on the wire by the action of pulling and feeding through. This will result in a straight length of wire,



Method of straightening Wire

which can be cut off to any required length. The tension or pull will be determined by experience, the amount depending on the strength of the wire. In the example under consideration it should be slight, owing to the small gage of the wire.

With this method, the size of the bore of the bent tube depends upon the size of the wire being straightened, and ⅛ inch should be satisfactory on a 0.007 inch wire. The amount of bend given to the revolving tube depends upon the amount of curvature in the wire—the smaller the curvature the less sharp need the bend be in the tube. It is a good plan to use a piece of soft tube, so that a number of forms of curve and degrees of bend can be tried until the most suitable shape is found. The amount of temper in the wire will also affect the curve of the revolving tube, the shape of which should be symmetrical. Since, by this method, no heat or excessive strain is put on the wire to be straightened, the character of the wire will not be affected in any way.

MACHINERY'S SCRAP-BOOK

Interesting Engineering Items Arranged in Compact Time-saving Form

LEAD WOOL

Lead wool is made of lead which has been shredded to about the size of heavy thread. After being shredded, the lead fibers are either collected in bundles and twisted together somewhat, or they are supplied in continuous strands coiled on reels. Lead wool is used principally for calking pipes, the lead being forced into the joint cold against a backing of hemp or tarred yarn. It is considered a good substitute for molten lead in calking joints for gas mains. The use of lead wool decreases the cost as compared with the use of molten lead. Very uniform results are also obtained by the use of lead wool, especially when calked with pneumatic hammers.

MAGNET STEEL

Alloy steel is used for making permanent magnets. The composition of the steel depends to a large extent upon the class of service for which the magnets are to be used. Telephone magnets, for instance, are made from 0.50 to 0.60 per cent carbon steel, containing a fairly high percentage of manganese. When a stronger magnet is required, as for magnetos, a 0.50 to 0.60 per cent carbon steel, with from 3 to 7 per cent of tungsten, is used. Steel containing 5½ per cent of tungsten makes excellent permanent magnets. The grain of the steel should be such that, when heated above the decalescence point and quenched, it will show a fine-grained fracture.

ANNEALING ALUMINUM

Correct annealing of aluminum is dependent upon both time and temperature. Frequently the length of the annealing period has a more important bearing on the mechanical properties than has the temperature. Although aluminum is distinctly a malleable metal, it frequently is necessary to anneal it two or three times during the forming of an intricate piece. The procedure is to work the piece to a certain stage, anneal it, and repeat the process until the desired shape is obtained. Sheet aluminum can be annealed most efficiently in a muffle furnace, where the heat can be obtained by radiation. If such a furnace is not available, the work may be annealed quite satisfactorily in an open fire of clean coke, over a brazier's gas hearth, or over the flame of the benzoline or gasoline blow-torch. Owing to the relatively low melting point of aluminum, which is approximately 1210 degrees F., great care must be taken during annealing to prevent the metal from melting. The annealing temperature varies from 700 to 900 degrees F., depending on the thickness of the metal and the length of time that it is subjected to the heat. Tests have shown that short exposures in the annealing temperature, ranging from three to thirty minutes, confer workable properties on the metal.

QUARTER-TURN BELT DRIVES

When two pulleys are mounted on shafts located at right angles to each other and are connected by a belt, this is known as a *quarter-turn drive*. Such drives should be avoided, if possible, because the belt is distorted as it twists around from one pulley to another, and, moreover, the contact between the belt and the pulleys is reduced, owing to the angular position of the belt. When installing a quarter-turn drive, it is important to align the pulleys in the proper manner. A general rule for aligning pulleys connecting shafts which are not parallel is as follows: The center of the face of the *driven* pulley must be aligned with the center of that face of the *driving* pulley from which the belt leaves.

AQUA REGIA

Aqua regia is a mixture composed of three parts of muriatic acid and one part of nitric acid; it has a reddish yellow color, and has the peculiar quality of dissolving gold, platinum, and other rare metals which are insoluble in other acids. In many instances, it is used as an etching fluid, especially for high-speed steel. It should be used immediately after being prepared or mixed, as it loses its properties even after a short time.

ABSOLUTE TEMPERATURE

A point has been determined on the thermometer scale which is called the *absolute zero*, and beyond which a further decrease in temperature is inconceivable. This point is located at — 273 degrees Centigrade, or — 459.2 degrees Fahrenheit. A temperature reckoned from this point, instead of from the zero on the ordinary thermometers, is called *absolute temperature*. To find the absolute temperature, when the temperature in degrees F. is known, add 459.2 to the number of degrees F. For example, find the absolute temperature of the freezing point of water (32 degrees F.). According to the rule given, 459.2 + 32 = 491.2 absolute temperature Fahrenheit.

SLUSH CASTINGS

The process known as slush-casting is employed extensively in the production of ornamental objects made of spelter or zinc. In this process the metal in the mold is poured back into the ladle as soon as a thin layer next to the mold has set; thus, hollow and, therefore, relatively light castings are produced. The molds used are of metal, usually bronze or brass, which can be machined evenly and which will not be injured by the molten metal. The process is substantially as follows: The metal is poured into the hollow mold until it is full, and then the mold is immediately emptied, leaving a thin-walled casting chilled upon the inside surface. The mold is usually mounted upon trunnions or otherwise arranged to facilitate rapid emptying. Because of the extensive use for ornamental purposes, castings so produced are often plated, stained, or treated in other ways to produce color effects.

STRENGTH OF MANILA ROPE

Manila rope is made from fiber or hemp obtained from a plant that is a native of the Philippines. Its strength varies considerably, not only with the quality of the fiber and the method by which the rope has been made, but also with the weather conditions under which it is used and the size and mounting of the sheaves over which it is run. Deterioration and wear is generally due to defective sheaves, excessive load, and exposure to outdoor atmospheric conditions. Manila rope in fairly good condition, ½ inch in diameter, should safely support 250 pounds; ¾ inch in diameter, 750 pounds; 1 inch in diameter, 1500 pounds; 1¼ inches in diameter, 2000 pounds; 1½ inches in diameter, 2500 pounds; 1¾ inches in diameter, 4000 pounds; 2 inches in diameter, 5000 pounds; 2¼ inches in diameter, 7000 pounds; and 2½ inches in diameter, 9000 pounds. When the load is supported by two or four parts of the rope, it is advisable not to multiply the load by two or four directly, but to make the load on several parts of rope slightly less than the theoretical safe load would be, figured from the safe load on a single rope, especially for large ropes. For example, when the safe load for a 2-inch rope is 5000 pounds, the safe load on two parts of rope may be 9000 pounds, and the safe load on four parts, 16,000 pounds.

QUARTERING MACHINE

A quartering machine is a special design of horizontal boring machine that is employed exclusively for boring the crankpin holes in pairs of locomotive driving wheels. The holes in each pair of wheels must be 90 degrees apart and they are bored after the wheels are forced on the axle. The pair of wheels is placed between the centers of the quartering machine, and the holes are bored by two short boring-bars. One bar is located on each footstock or center base, and it is carried by a slide that is adjustable. The angle between the ways upon which the slides are mounted is 90 degrees, so that the angular distance between the crankpin holes is also 90 degrees, irrespective of the adjustment of the boring-bars which is made to conform to the radius of the crankpin circle. The crankpins in each pair of driving wheels are placed 90 degrees apart in order that one side will be developing maximum power when the other side of the locomotive is passing the dead center position, thus equalizing the distribution of the power developed and making it impossible for both sides of the locomotive to be on the dead center at the same time.

PRIMING

If the steam which is generated in a boiler contains an excessive amount of moisture as it passes into the steam main, this condition is commonly referred to as *priming*. This may be caused by impure water, too high a water-line, the presence of oil, or of certain alkalies used in the removal of scale. Priming may also be caused by forcing a boiler beyond the capacity for which it is designed. When the steam rises from the surface of the water with too high a velocity, it has a tendency to carry more or less spray with it, which, when once in suspension, does not readily settle against a rising current, and thus passes over into the main with the steam.

GEOMETRIC LATHE

The machine known as a "geometric lathe" is a special machine designed for engraving intricate designs on fine dies or plates. The elaborate scroll work found on paper money is an example of the engraving done by the geometric lathe. While this machine is known as a "lathe," it is, in reality, a highly specialized type of engraving machine. The geometric lathe was invented by Charles W. Dickinson, and was first used for engraving bank-note plates in 1862. This machine produces an almost endless variety of geometric figures by utilizing various combinations of gears, cams, and eccentrics. By varying the patterns for treasury notes, postage stamps, revenue stamps, etc., counterfeiting is made difficult. Moreover, the operation of one of these machines requires an expert mathematician. The lathe has a number of superimposed flat plates which are actuated by cams and gearing, and the die to be engraved is held by the top platen or chuck. The hardened steel tool which is sometimes pointed with a diamond is fastened in a stationary position, and the die is given the various movements necessary to produce each pattern.

WHITE METAL COMPOSITIONS

The term "white metal" is applied to a number of alloys containing mainly zinc and tin, or lead, tin, and zinc. White metals are used for bearings on railroad cars, generators, motors, etc. The composition of one of these white metals used as a bearing metal is as follows: Lead, 33 per cent; tin, 54 per cent; antimony, 10.6 per cent; and copper, 2.4 per cent. White metal made according to the specifications of the United States Navy Department consists of 88.8 per cent of Banca tin; 3.7 per cent of best refined copper; and 7.5 per cent of regulus of antimony, well fluxed with borax and rosin in mixing. Several English railways use from 73 to 77 per cent of tin; from 15 to 19 per cent of antimony; and from 7 to 9 per cent of copper. White metal is sometimes used as a pattern material, especially when it is necessary to avoid shrinkage. The addition of antimony makes the metal almost entirely free from shrinkage upon cooling.

HYDROCHLORIC ACID

The acids that are most frequently made use of in the industries for etching and for similar purposes are hydrochloric or muriatic acid, nitric acid, aqua regia, hydrofluoric acid, and sulphuric acid. Hydrochloric acid, also known as muriatic acid, is an aqueous solution of hydrogen chloride (chemical formula, HCl). In the mechanical industries it is used either alone, or mixed with other acids as an etching fluid. It is colorless when pure, but the commercial acid has a yellow tint, due to impurities. Concentrated acid contains 32 per cent of hydrochloride and has a specific gravity of 1.16. Dilute acid, containing about 18 per cent of hydrochloride, has a specific gravity of 1.09. Hydrochloric acid gives off poisonous fumes if left open in the air, the fumes being chlorine gas. An antidote for chlorine gas poisoning consists of powdered chalk or soap dissolved in water.

SWITCHBOARD MATERIALS

The materials from which switchboard panels are made must be fireproof, have insulating properties, be strong mechanically, and, for the average installation, must be reasonable in price. The two materials in general use are slate and marble. Slate is used to a much greater extent than any other material for switchboards. It must be carefully selected for insulating qualities and mechanical strength. When used in its natural color, consideration is also given to appearance. The four varieties of slate furnished for switchboard use are: (1) Natural black slate. (2) Dull black marine finished slate. (3) Black enameled slate. (4) Marbleized slate. Owing to its greater strength as compared with marble, slate is recommended for switchboard use when the potential used directly on the panel does not exceed 1200 volts for natural black slate and 650 volts for dull black marine finished slate. Marble is suitable when the potential directly on the panel does not exceed 3300 volts, and should be used in all cases when the potential on the apparatus mounted directly on the panel without insulating bushings exceeds 1200 volts. There are several varieties of marble suitable for switchboard work, the most serviceable being blue Vermont marble. Pink and gray Tennessee, white Italian, and white Vermont marbles are used to a less extent.

INGOTS MADE BY BOTTOM-POURING

In bottom-pouring an ingot, the metal is poured into a vertical runner and flows up into the mold through an opening in the bottom. As the runner is kept full of metal by the constant flow from the ladle, the level in the ingot mold gradually rises. While all metallurgists and steel makers do not agree that bottom-poured ingots possess the superior qualities which others claim for them, the principal advantages from this method of pouring may be summarized as follows: The metal flows up into the mold very quietly and without any splashing such as occurs when pouring from the top and especially when first beginning to pour into the bottom of the mold. This splashing action which accompanies top-pouring results in a poor surface condition of the ingot. It is also claimed that when pouring from the bottom there is less tendency to entrap dirt or foreign matter in the ingot, as this is carried outward to the surface of the mold when the metal flows up through the opening in the center. Still another advantage claimed for the bottom method of pouring is that there is practically no oxidizing action of the air upon the stream of metal which flows from the ladle. The distance between the bottom of the ladle and the top of the runner is only a few inches, so that there is no time for oxidizing action to occur, which is not the case when the metal is poured from the top and there is a long stream extending from the ladle to the level of the metal in the ingot. Some metallurgists contend that the advantages which might accrue from bottom-pouring are partially, if not entirely, offset by a slagging off of the refractory lining in the runner; others claim that such slagging action can be reduced until it is negligible.

Economies Effected by Conveyor Systems

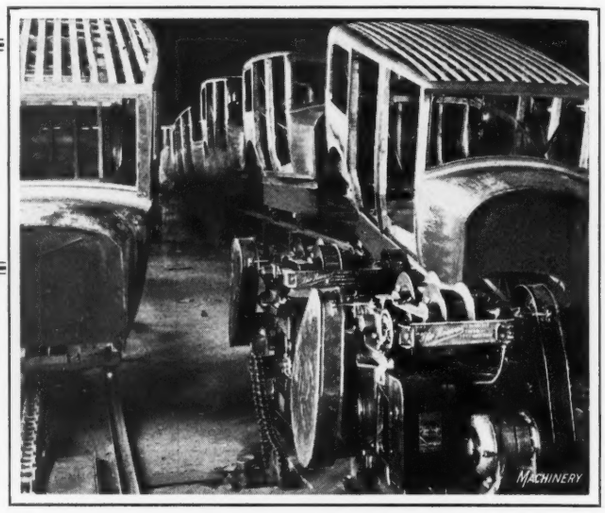


Fig. 1. Conveyors driven by Constant-speed Electric Motors through Reeves Variable-speed Transmission

THE demand for greater output and decreased prices in the automobile industry has brought into use a great variety of equipment for increasing production and lowering costs. An interesting example of this is found in the plant of the C. R. Wilson Body Co., Detroit, Mich., where a complete system of power-driven conveyors is used for handling the bodies built by this company for the Overland, Willys-Knight, Jewett, and Reo cars. Previous to February, 1923, all the automobile bodies built by this company were transported through the plant on shop trucks, but the installation of a few conveyors quickly proved that substantial economies could be effected by the use of power-operated conveyors. Up to the present time, 12,000 feet of conveyor system have been installed, and 5000 feet more are to be added. The conveyors now in use handle the bodies during the paneling, painting, and trimming operations.

The extent of the savings realized by this conveyor system is shown by a recent report of the engineering department of the company. In this report it is stated that through the use of the conveyor system, a saving of 10 per cent in the labor costs has been made, which means that the number of men required in these departments has been reduced by 500. The annual wages of these men is about $975,000. In addition, the production has been doubled without materially increasing the floor space.

It is conservatively estimated that the saving in floor space resulting from the installation of the conveyor system is equivalent to 250,000 square feet having a rental value of $250,000 a year. This brings the total saving up to $1,225,000 a year, not including the interest in reduced inventory.

Production Control

As the conveyor system involves a considerable investment, it is important that careful attention be given to every detail of its operation in order that the best results may be obtained. One of the most important factors is the ability to control the speed of the conveyor accurately, because this determines the rate of production. Variable-speed alternating-current motors equipped with common rheostats, giving eight or ten different speeds, were first employed to drive the conveyors. With this equipment, the desired speed was not always obtainable, and even when secured it was subject to considerable variation, as the load on the conveyor changes considerably. A somewhat larger motor than would be required for the average or usual speed was necessary in order to provide sufficient power to carry the load when operating the conveyor at low speeds. However, at the time the conveyors were first installed, when the production was nearly constant, the alternating-current variable-speed motors served the purpose very well.

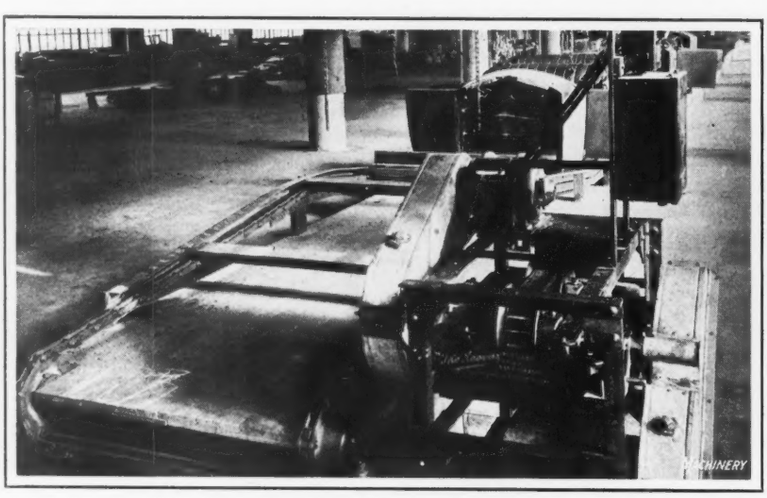


Fig. 2. Double-chain Conveyor with Variable-speed Control

With the changing conditions which made it necessary to vary the schedule between the wide limits of 165 and 500 bodies per day, it was found desirable, or practically necessary, to provide a more flexible means of controlling the speed. This was accomplished by installing constant-speed motors and employing a variable-speed transmission made by the Reeves Pulley Co., Columbus, Ind., as shown in Figs. 1 and 2, for controlling the speed of the conveyors. The particular type employed is known as the Reeves No. 1, Class F transmission, and is capable of transmitting 6¼ horsepower at minimum speed and 10½ horsepower at maximum speed. The maximum speed variation is 3 to 1, and in the present installation the conveyor speeds range from 13 to 40 feet per minute.

A two-horsepower motor has been found to give sufficient power for operating the variable-speed transmission, whereas the variable-speed motors previously employed were of the three-horsepower size. Up to the present time, eighteen of these variable-speed transmissions have been installed. With this installation it is possible to control the conveyor speed over the entire speed range within a limit of less than one revolution per minute. Thus the exact speed desired can always be obtained instantly. To change the speed, it is only necessary to turn a handwheel.

By employing a variable-speed transmission in place of a variable-speed motor, it has been possible to use a two-horsepower constant-speed motor in place of the former three-horsepower variable-speed motor. The saving on the eighteen motors due to the difference in price of the two- and three-horsepower sizes is approximately $1080. The interest on this, plus the savings in depreciation and repairs, totals about $198 a year. As the variable-speed trans-

mission allows the motor to run at its most efficient constant speed, less current is consumed than with the variable-speed motors formerly used. This saving in power alone is estimated to be approximately $667 a year, which brings the total saving up to about $865 a year. On this basis the entire original cost of the variable-speed transmissions will have been saved in 2½ years. The operating cost of the eighteen Reeves transmissions is only $1.22 a day.

Of course, the greatest advantage of the variable-speed transmission is that it enables the production schedule to be accurately controlled. While it is difficult to express, in dollars, the advantages resulting from the installation of an accurate production control, it will be obvious to any manufacturer that this saving is considerable.

* * *

DRILLING AND REAMING AUTOMOBILE FRONT AXLES

By equipping a gang drilling machine with two radial heads and a turn-over jig, an increase in production of over 100 per cent has been made in drilling and reaming Star front axles, the increased production being forty axles per hour. With this additional equipment it is possible to ream the king-pin holes in one part at the same time that another part is being drilled, and also to reload the jig while the drilling is being done. Thus both reaming and reloading time is saved on the job.

The accompanying illustration shows the machine on which this set-up has been made. This is a four-spindle adjustable-head all-geared gang drilling machine built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill. The radial heads are of a jointed construction so that they may be swung into the reaming position without interfering with the main spindles used for drilling the king-pin holes. While one axle is being drilled under the main spindles of the machine (auxiliary heads being used for the spring-pad holes), the king-pin holes of the axle in the outer or reversed position of the turn-over jig are reamed, the drill bushings being thus out of the way of the reamers. The finished axle is then removed and a new forging placed in the jig, the reaming and reloading being completed during the drilling operation on the work in the opposite position of the jig directly under the machine spindles.

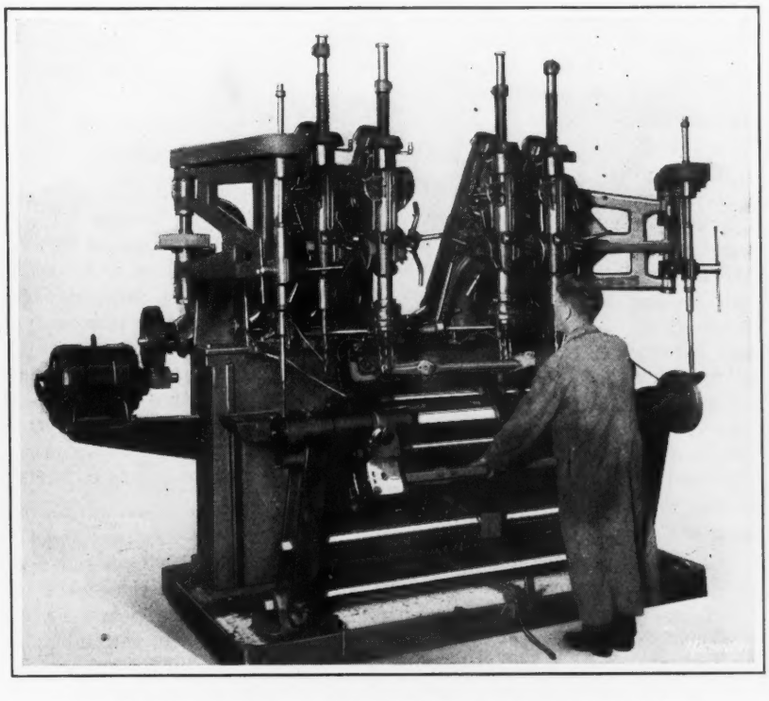


Fig. 1. Drilling and Reaming Automobile Front Axles on a Gang Machine arranged with Two Radial Heads and a Jig

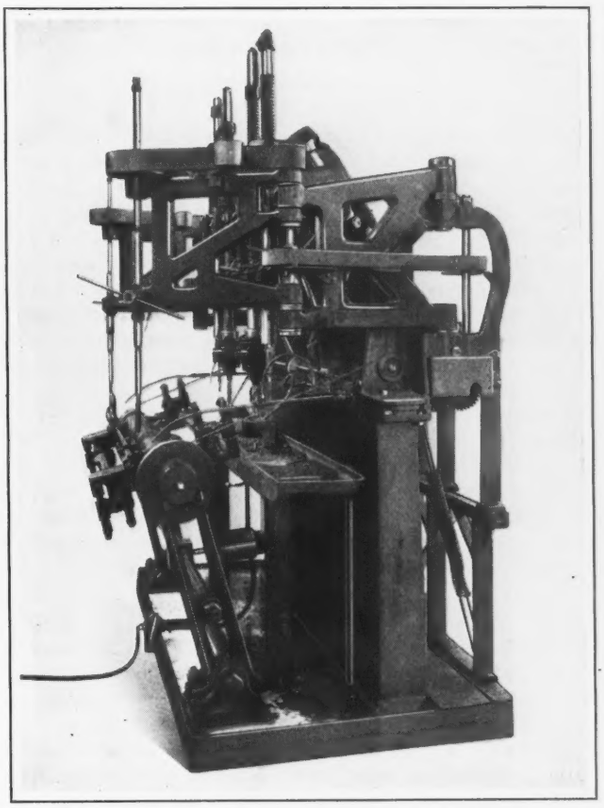


Fig. 2. End View of the Axle Drilling and Reaming Unit

There is an air cylinder at the base of the machine which is actuated by a foot-pedal to push the jig to the outer position, as shown in Fig. 2, so that it will clear the table when turned over. The air cylinder then operates to draw the jig back to the working position. Less than ten seconds is required to index this jig. There is a quick lateral adjustment for the jig to bring the bushing guides to the center of the boss on the axle forging, which has a slight variation due to shrinkage in the over-all length of the forging. Likewise the outer main spindles are quickly brought to the center of the bushing by the movement of the lever at the center of the machine directly in front of the operator.

* * *

TRADEMARK PROTECTION IN EUROPE

A collection of regulations relating to trademark protection in different European countries has been prepared by the Bureau of Foreign and Domestic Commerce, Washington, D. C., and is published as Trade Information Bulletin No. 155, as mentioned in December MACHINERY. This bulletin gives a general outline of the conditions surrounding trademark protection in Europe, and the need for adapting a trademark to specific export markets. It points out, for example, that words used in trademarks should be easily pronounceable in the language of the people who will use them. There should be no objectionable meaning to the word in the foreign language, and the trademark itself should contain no coloring or illustration objectionable to a certain race or people. The bulletin also reviews the conventions and treaties made between nations in regard to trademarks, and summarizes the essentials of the trademark laws in Europe.

ARC-WELDING CAST IRON WITHOUT PREHEATING

By C. J. HOLSLAG, Chief Engineer,
Electric Arc Cutting and Welding Co., Newark, N. J.

In view of the fact that the writer is holder of United States patent 1,305,362, issued June 16, 1919, which gives him the exclusive license to use a transformer for arc-welding, no matter what the construction of the transformer, he believes that the present article should be published in direct reply to the article that appeared under the same title in November MACHINERY. Under the patent mentioned, the transformer can be so constructed as to give intermittent or continuous arcs in the same machine, and anyone purchasing a machine adapted only to intermittent work must feel rather defrauded when he finds that a general machine would have cost him no more. The writer has been interested in arc welding ever since its advent into this country, and has spent a great deal of his own and other people's money investigating electrodes for welding cast iron cold, leaving the casting readily machineable. Some of the results of this investigation with regard to electrodes will be described in the following.

Use of Nickel as an Electrode in Welding

With the ordinary steel or iron electrode, the arc deposits a nice line or "bead" on the cast iron. However, as the melted cast iron is instantly chilled by the surrounding cold mass, there is a line of metal underneath and around the weld that is both hardened and weakened. This results in the weld pulling away where a great mass of electrode has been deposited, and also in dulling and breaking tools when machining methods other than grinding are necessary. In fact, it was not so long ago that the writer and others were ready to state positively that surface cast iron could not be welded without this chilled layer being present, unless the casting were first preheated.

Fortunately, nickel has the property of so merging with cast iron that this layer does not exist when nickel is used for the electrode, and entirely machineable welds can be made. However, the cast iron must not be too hot, and so it is better to proceed by welding a little at a time. There are some adherents of this method who think that an intermittent arc is the best one for the process. So far, alternating current is the only means by which the intermittent arc can be obtained, as all direct-current apparatus gives a continuous arc.

Development of the Process

A short arc is desirable in all welding, but especially so in this process, in order to keep down the heat. The alternating-current arc can be adapted either to the intermittent or to the continuous-interrupted method. However, it is absurd to state that direct current cannot be used for this process because, as far as the historic delving of the writer has produced facts, it was on the only true direct current made—that of the storage battery—that this process was developed. Investigations make it appear that about 1914 it was discovered that, with a 12-volt storage battery and a nickel electrode about ⅛ inch in diameter, nickel could be spotted into clean cast iron. The method seems to have sprung into being in Buffalo, Cleveland, and Detroit simultaneously. This storage battery arc was nowhere nearly so useful as a generator arc with higher voltage, and as explained, the alternating arc of a higher voltage, with either a non-continuous or a continuous-interrupted arc, is better yet for this work.

Nickel Alloy Electrodes

Far more useful than pure nickel is an alloy of manganese, copper, and iron, with nickel predominating. By the use of this alloy and careful calking of each bead, practically continuous welding can be done. The tensile strength of the alloy is about equal to that of steel, while the appearance and weight are practically those of cast iron. In the opinion of a great many satisfied users, this nickel welding or spotting process has placed arc welding in the lead over oxy-acetylene gas welding for such work, because, with one exception, gas welding requires preheating. This exception is the brazing of cast iron by using bronze at a comparatively low temperature, the temperature being obtained by any means possible. In fact, the writer can remember doing such work over thirty years ago with a charcoal fire. One disadvantage of this method of gas welding is its appearance, because few manufacturers can tolerate the yellow streak produced in otherwise clear metal.

* * *

HIGH SPEED OF ELECTRIC LOCOMOTIVES

The latest developments in speed of railroad locomotives was demonstrated at public tests made by the General Electric Co. at its Erie, Pa., plant a few weeks ago, when an electric locomotive designed for a French railway attained a speed of from 95 to 105 miles an hour on a test track 4½ miles long. The locomotive is manufactured jointly by the General Electric Co. and the American Locomotive Co. The weight of this locomotive is approximately 80 tons on the drivers, and it is designed for a maximum running speed of up to 80 miles per hour. It is generally considered that the maximum practical speed for ordinary passenger trains is from 60 to 70 miles an hour, because present tracks and bridges do not permit of higher speeds with safety. If the speed of railroad traveling is to be materially increased above this figure in the future, electric traction and multiple unit trains must be employed. In England, previous to the war, a regular train service was maintained in which 75 consecutive miles were covered in 60 minutes, but speeds as high as this in regular passenger train operation are unusual, and have not been duplicated elsewhere.

The most remarkable speed that has ever been attained on a railroad track was achieved in experiments carried on in Germany about twenty years ago. In these experiments electric cars attained a speed of 130 miles an hour. However, this speed was found impracticable in regular service, because it was impossible to provide a track that could stand up under the severe strains imposed upon it, except at a cost that would be entirely prohibitive. Generally speaking, a speed of 100 miles per hour is obtainable by railway trains only under the most favorable conditions and where the track is straight and level for a long distance; such a speed can seldom be maintained except for a short distance and requires a road bed and track of the very best construction.

* * *

COMMERCE YEAR BOOK FOR 1922

The Department of Commerce, Washington, D. C., has just published a book of 692 pages entitled "Commerce Year Book—1922" containing a great deal of information on both domestic and foreign commerce. The price of this book is 60 cents, and it may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. Briefly, the book contains general production statistics; information on employment, immigration, and wages; review of the 1921 census of manufactures; review of the major industries in 1922 and the early months of 1923; the foreign trade of the United States in 1922 and the tendencies in the first half of 1923; and a brief review of conditions in foreign countries.

* * *

The Connecticut Yankee still continues to have the most inventive mind in the world. In 1922 there were more patent applications per 1000 inhabitants filed from the state of Connecticut than from any other state in the union, or any other country in the world. California took second place in the number of patent applications in proportion to population. The industrial development of the Pacific Coast in the near future may well bear watching.

WORK OF THE DEPARTMENT OF COMMERCE

The annual report of the Secretary of Commerce, covering the work of the Department of Commerce, has recently been issued. The keynote of the report is the general recovery in production and employment and the expansion in foreign trade that has taken place during the year. American manufacturing industries, it is stated, were not, on the whole, seriously affected by the situation in Europe, because less than 1 per cent of our total industrial production depends upon the European market, and a large expansion in the sale of American products took place in South America and the Far East. In the agricultural field, the effect of the European situation was far more serious than in the manufacturing industries, because our farmers depend far more upon European markets for the sale of their surplus products than our manufacturers.

The work of the Department of Commerce in promoting the foreign trade of the country is indicated by the fact that inquiries and requests for assistance now average over 3000 a day, or approximately four times the daily average when Secretary Hoover became head of the department. The director of the Bureau of Foreign and Domestic Commerce states that during the fiscal year the services of the bureau have been called upon in actual transactions of export business amounting to more than $400,000,000. The statistical services of the department on imports and exports have not only been extended during the last year but have also, for the first time, been brought up to date.

Exhaustive scientific research into various problems have been carried on at the Bureau of Standards. Many of these have been conducted in cooperation with the industries, notably the automobile industry, the petroleum industry, and the building industry. The Division of Simplified Practice has also done a valuable work during the year. There are now approximately 125 different industrial groups that are taking definite steps toward simplification in their products.

Among the legislative recommendations made in the report is one relating to radio regulation and one relating to commercial aviation. The method of taxing American merchants residing abroad is also touched upon.

TWENTY YEARS IN THE MACHINE TOOL INDUSTRY

The accompanying diagram showing the shipments of machine tools from 1901 to 1923, inclusive, has been prepared by Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, from figures supplied by twenty-nine machine tool building firms. The shipments for 1913 are assumed as 100 per cent. The line shown in dots and dashes is the "trend" line, which indicates what the "normal" machine tool demand would have been if evenly distributed. This trend line indicates that the normal increase in the machine tool business of the twenty-nine firms referred to is about 23 per cent in ten years.

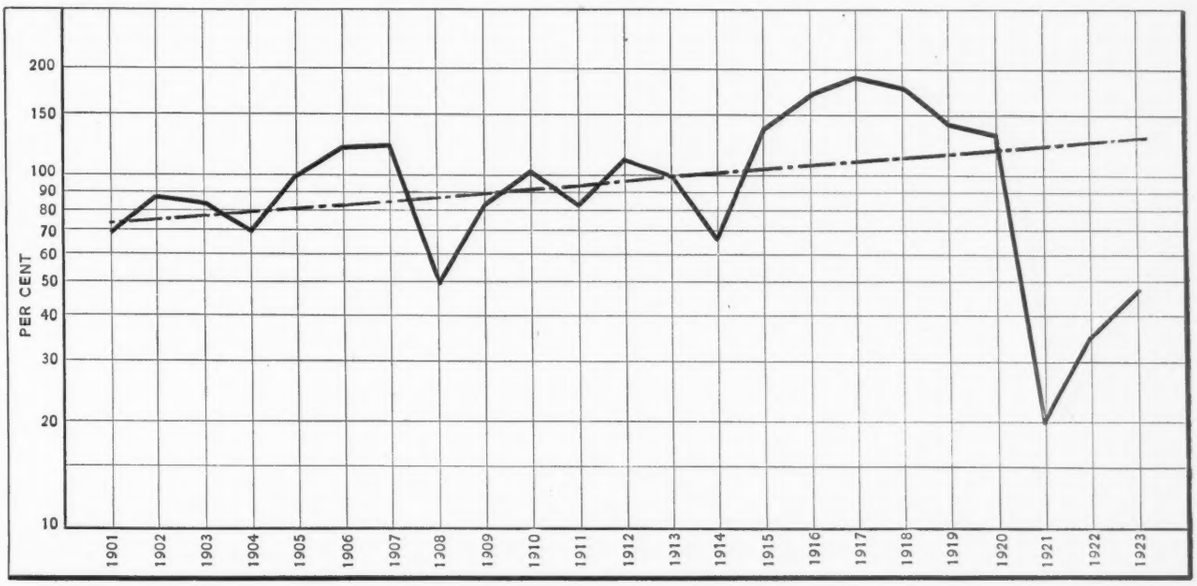


Diagram showing Shipments of Machine Tools from 1901 to 1923

The diagram also shows that the production from the middle of 1915 until the end of 1920 was greater than what might be considered normal, while since 1921 it has been considerably less than normal. The peaks and valleys in the machine tool industry are also clearly shown. In 1917 the business was nearly double that in 1913. In 1908 it was one-half, and in 1921 only 20 per cent of that in 1913. The accompanying table shows the shipments in percentages of the 1913 shipments.

* * *

INCREASED TRANSPORTATION REQUIREMENTS

A committee of the United States Chamber of Commerce has estimated that there will be an increase of 25 per cent in passenger traffic and 33 per cent in freight traffic during the next ten years. To provide for this growth, an investment of close to $8,000,000,000 will have to be made in transportation facilities. The committee recommends that no change be made in the Transportation Act, because the railroads must be permitted to continue to improve their financial position if they are to be able to attract sufficient capital for necessary expansion. While present passenger fares and freight rates may seem high, compared with pre-war conditions, the operating costs of the railroads have risen in an even greater ratio. As a single example, it may be mentioned that freight cars that could be purchased for $825 in 1907 cost $2300 in 1923. The cost of passenger cars nearly quadrupled in the same time.

PERCENTAGE OF SHIPMENTS OF MACHINE TOOLS OF 29 FIRMS FROM 1901 TO 1923 (1913=100 PER CENT)

Year	Per Cent	Year	Per Cent	Year	Per Cent
1901	69.5	1909	84.4	1917	192.1
1902	87.8	1910	104.8	1918	181.2
1903	85.3	1911	83.9	1919	143.6
1904	70.8	1912	112.4	1920	135.5
1905	103.1	1913	100.0	1921	20.5
1906	122.5	1914	66.3	1922	25.6
1907	125.0	1915	138.3	1923	48.5
1908	50.3	1916	172.2	....	.....

Machinery

The Machine-building Industries

THE general business situation indicates continued improvement. The production of basic commodities shows a slight increase over the summer months, and the volume of freight shipments continues heavy. After a decline for four months, the Federal Reserve Board's index of production in the basic industries showed an increase of 3 per cent in October—the last month for which complete statistics are available. Another indication of activity that makes itself felt directly and indirectly in numerous industries is the volume of building construction. Contracts for new buildings awarded during the latter part of the year are for a total considerably higher than ordinarily at this time of year.

It is true that buying is done on a more conservative basis and that smaller-lot, but more frequent, purchasing is in evidence. The efficient transportation now provided by the railroads is one reason for this buying policy. It is not necessary to order far ahead of needs, because goods can be delivered at comparatively short notice. The Federal Reserve Bank of Cleveland says that present conditions bear testimony to the underlying strength of industry as a whole; to the stability of our financial system; to the ability of buyers to purchase what they need; and to the consumptive requirements of the country, in face of a minimum purchasing power in Europe.

The Machine Tool Industry

There has been no appreciable change in the situation in the machine tool industry during the past month. The machine tool demand in October and November was slightly greater than in the preceding months. There is no prospect of any falling off in this field; nor is any considerable increase expected. New business in the machine tool field will be largely for replacement purposes. Probably a greater number of orders will be placed in January and February than for the past month, because the number of inquiries received indicate that orders have been held back until the new year.

The automobile industry remains one of the most active buyers of machine tools, and a scattered demand for single tools or small lots for railroad shops has also been a feature in the market. The second-hand market in machine tools continues about normal.

The Automobile Industry

During the past year the automobile industry has set a new record, and the unusual activity in this field has produced a considerable volume of machine tool business. As a matter of fact, this industry has been the largest single purchaser of machine tools, the railroads coming next. The November output of automobiles was 325,000 cars and trucks, the largest ever recorded for this month. The output in October was 365,000 cars and trucks. In the eleven months ending November 30, the total production was 3,717,700 cars and trucks, indicating that the total production for the year will be about 4,000,000.

The continued activity in this industry during the fall months has been a surprise both to the manufacturers themselves and to others indirectly concerned with that field. Sales continue at an unusual rate, production is heavy, and there has been no appreciable falling off from the high records established during the spring and summer months. The entire industry is optimistic; but while the position of the industry as a whole is becoming stronger, it is evident that comparatively few leaders in the field will survive, while numerous weaker concerns will pass out of existence.

The registration of automobiles in the United States is now about 14,000,000. It is generally conceded that a production of 4,000,000 cars a year cannot continue indefinitely, because in time the main business will be for replacement purposes and then a much smaller number of cars will be required annually. The Federal Reserve Bank, having adopted a certain "normal" for production in different lines, estimates that the production of passenger cars is about 70 per cent above this normal, while the production of trucks is but slightly in excess.

The Iron and Steel Industry

Production in the iron and steel industry is now from 70 to 75 per cent of capacity, but prospects are generally considered favorable, because steel is being consumed by the industries of the country at a comparatively high rate. The outstanding feature of the iron and steel market in the last six weeks was a sudden heavy buying movement in pig iron after several months of decline. As a result, pig iron prices advanced slightly; but as the stocks still in the hands of the producers are large, it is doubtful if the price increases can be maintained. Statistics indicate that there was more pig iron on hand and fewer unfilled orders at the end of October than at any time since the records have become available to the public. Lower pig iron prices would doubtless stimulate various industrial operations.

The Railroad Situation

Certainly no one can gainsay the statement that the general conditions in the country point toward a well distributed prosperity, considering the two facts that the country has been able to absorb 4,000,000 automobiles during the past year, while the freight movements, which are also an index of purchasing power, have been the heaviest on record. The railroads during the first ten months of 1923 handled the greatest freight traffic in their history, according to reports on file with the Bureau of Railway Economics. The traffic for that period amounted to 386,027,840,000 net ton-miles, an increase of 2 2/5 per cent over the corresponding period in 1920, which marked the previous high record. In the Eastern district, freight traffic during the first ten months of 1923 was approximately 35 per cent greater than for the corresponding period of 1922. In the Southern district an increase of nearly 25 per cent was reported, and in the Western district an increase of nearly 20 per cent.

The Interstate Commerce Commission has issued a report covering the past year, which credits the railroads with a remarkable record for efficient and economical operation. In spite of the greatly increased volume of freight, there are now over 100,000 surplus freight cars available. The salient factors that have made possible this excellent showing by the railroads are mainly the good condition of locomotives and cars, the large number of locomotives and cars placed in service, and the increases in mileage per day both of locomotives and cars. About 4000 new locomotives and 173,000 freight cars have been placed in service during the year.

Orders for nearly 100,000 new freight cars either have been placed or are about to be placed for 1924 delivery, and there are still from 20,000 to 25,000 cars, ordered for 1923, to be delivered during the coming year. Hence, it is evident that the railroad managements are determined to continue to keep their equipment ready for any volume of freight that may be offered. Incidentally, the building of such a large number of freight cars will reflect favorably upon many subsidiary industries. Heavy rail orders have also been placed during the latter part of the year.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Fellows Automatic Gear Grinder

AN automatic gear grinder with an adjustable involute control and other unusual features of design has been placed on the market by the Fellows Gear Shaper Co., Springfield, Vt. Because of its automatic operation it is only necessary, after setting up the machine, for the operator to locate and clamp the gear on the work-spindle and then pull a lever, after which the machine automatically takes care of the rolling action of the gear against the flat surface of the grinding wheel, indexing for each tooth, truing the flat face of the grinding wheel, and stopping the machine when the gear has been completed, regardless of whether it requires one, two, or more cuts. All operating levers are at the front, and the base is square, so that machines can be set end to end to economize in floor space. The entire gear-box and the auxiliary working members are automatically lubricated. Reduced to its simplest elements, the machine comprises a base carrying a grinding wheel head, which is adjustable for different gear diameters, and a slide carrying a member known as the "rolling head," which rolls the gear teeth against the wheel. The rolling action of this head is controlled by means of a master involute tooth.

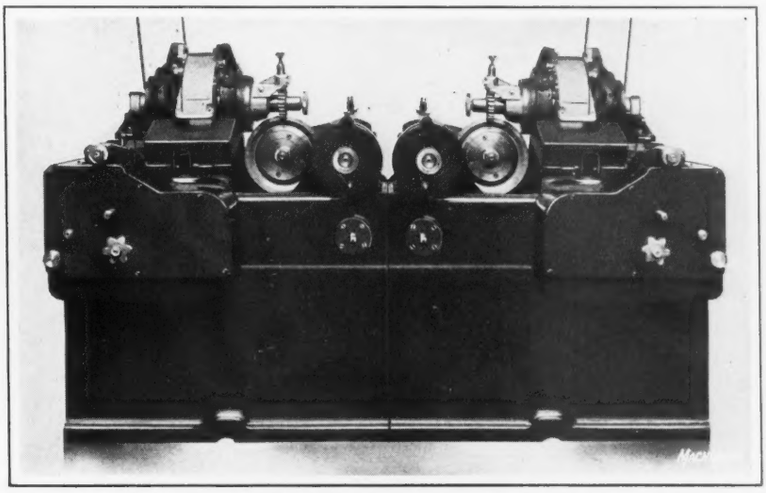


Fig. 1. Right- and Left-hand Fellows Automatic Gear Grinders placed Back to Back to conserve Floor Space

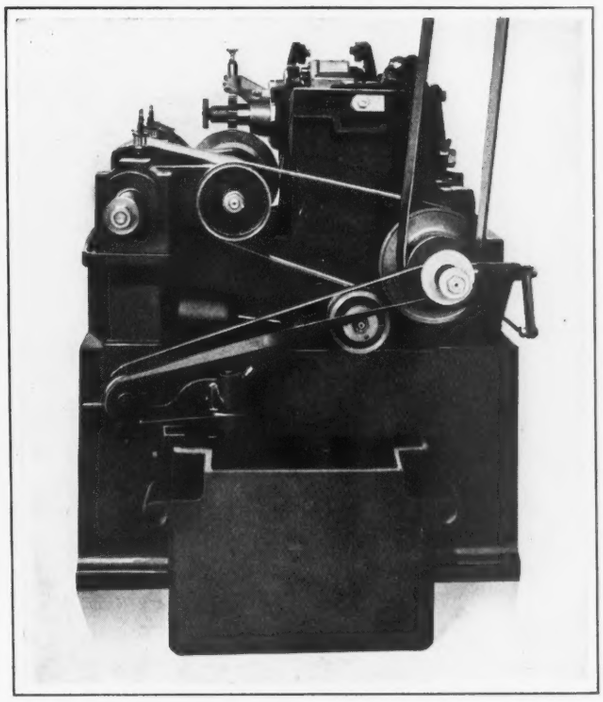


Fig. 2. Rear View of Gear Grinder, showing Main Drive

Function of the Master Tooth

The rolling head is of light weight, being made from a heat-treated aluminum alloy casting, and it is balanced to reduce the flywheel effect to the minimum. It oscillates on ball-bearing trunnions mounted on the slide, the latter being moved forward and backward by means of a barrel cam. The rolling head contains the index mechanism and index-plate, and is of such construction that indexing of the work can be accomplished without shock in one-tenth of a second. The master involute tooth is mounted on the outer end of the rolling head, as illustrated in Fig. 3. This is really a long involute gear tooth which contacts with an adjustable abutment representing a long straight-sided rack tooth. The master involute tooth is ground on a special machine and can be made accurate to within 0.0001 inch. Both this involute tooth and the abutment or master rack are made from alloy steel and hardened and ground. The rolling contact of the master involute tooth with the abutment resembles the action of a gear tooth rolling on a rack.

The most interesting part of this mechanism is the fine adjustment provided for the abutment that controls the pressure angle of the involute tooth being ground. By this means it is possible to control the accuracy of the finished product and bring it within the close tolerance of the reference gage that has been adopted as a standard. An additional advantage of this adjustment is that it provides for taking up any wear that may occur.

An important point in connection with the grinding of involutes is the necessity of retaining a constant pressure between the work and the grinding wheel. If this pressure should vary, the rolling action of the work against the wheel would not be positive and an inaccurately shaped tooth would be the result. Because the rolling head is an aluminum alloy casting, balanced and mounted on ball-bearing trunnions, comparatively little, if any, force is required to move it, and therefore an applied force is not expended in overcoming friction but instead exerts a positive and known pressure. The weight element is taken care of by fastening a wire cable to the rolling head, passing the cable over the idler and attaching weights on the free end. Removable weight sections are provided, so that the desired pressure between the master involute tooth and the

abutment can be maintained. As there is no flexible mechanism between the master involute and the abutment, the control of the work against the wheel is positive.

A feature of this machine is the small-sized grinding wheel that is used. The reason for using a small wheel is that a large wheel would necessitate the use of a long work-arbor, and the work-spindle would therefore be relatively larger and longer, making the entire operating mechanism heavier and more massive. Also, there is less vibration with the smaller wheel, and it can be trued faster. The machine is equipped with an automatic truing device with which only a light cut is taken. Having once determined the necessary amount of truing, the machine automatically duplicates this and the truing can be so timed that the wheel is dressed after the gear has made one or more revolutions as may be found desirable.

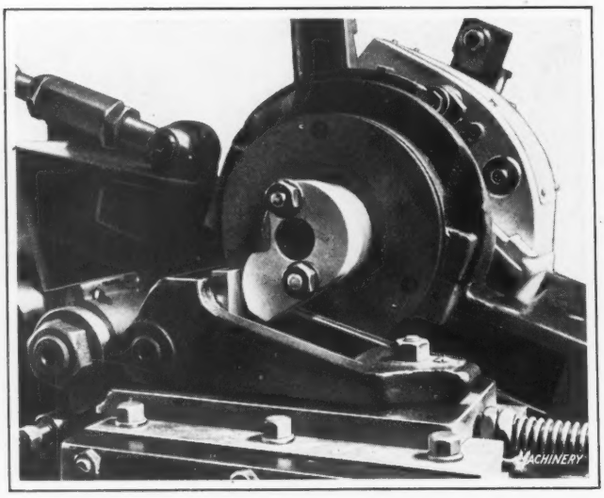


Fig. 3. Close-up View of Master Involute Tooth, Abutment, and Adjustment for Pressure Angle Control

Interchangeable Rolling Heads

In interchangeable manufacturing, it has long been recognized that if accurate concentric work is to be expected, the most vital surface should be selected as a locating point and the work located from this surface for all operations. In gear grinding, this practice can be followed effectively by using right- and left-hand machines for grinding the two sides of the teeth.

Another interesting feature incorporated in this machine to insure the production of concentric gears is the use of removable rolling heads. If arbors, index-plates, master forms, etc., must be changed for grinding different sizes of gears, errors may creep in, but by having the rolling heads interchangeable none of the vital members are affected in changing over from one gear to another. All that is necessary is to remove the caps from the trunnions, and the entire rolling head and its auxiliary mechanism can be easily lifted out and replaced by another complete head.

In grinding gears, standards of accuracy must be established and reference gages made for each size of gear that is to be ground. Tolerances that fulfill the requirements of ordinary interchangeable work are not close enough, as involute curves, to be satisfactory, must be kept within 0.0002 inch of an established standard for many purposes. Some means of checking or comparing ground gears with the established standard is essential if satisfactory work is to be obtained.

The involute measuring instrument used for this purpose is shown in Figs. 4 and 5. This instrument consists of two cylinders which represent the base circle of the gear to be measured. Held on an arbor concentric with these cylinders is the gear to be inspected. The cylinders are rolled on hardened and ground steel surfaces, and exactly in the same plane as these surfaces is a jewel contact point which bears against the involute surface of the tooth being measured. As the cylinders are rolled with the contact point bearing on a tooth, no movement of the indicator is visible if the curve is perfect. Any variations from the theoretically correct involute are indicated in ten-thousandths of an inch.

GRAHAM PULLEY GRINDING MACHINE

A grinding machine designed for finishing the face or belt surface of pulleys after the hole has been machined is being placed on the market by the Graham Mfg. Co., Inc., 71 Willard Ave., Providence, R. I. The face may be ground straight, crowned, or hollow, and it does not matter whether or not the edges of the pulley or the hubs have been previously finished. The machine is not suitable for grinding cone or flanged pulleys. The grinding is done on the edge of a cup or ring abrasive wheel, attached to a horizontal spindle, the pulley being held on a stationary vertical arbor

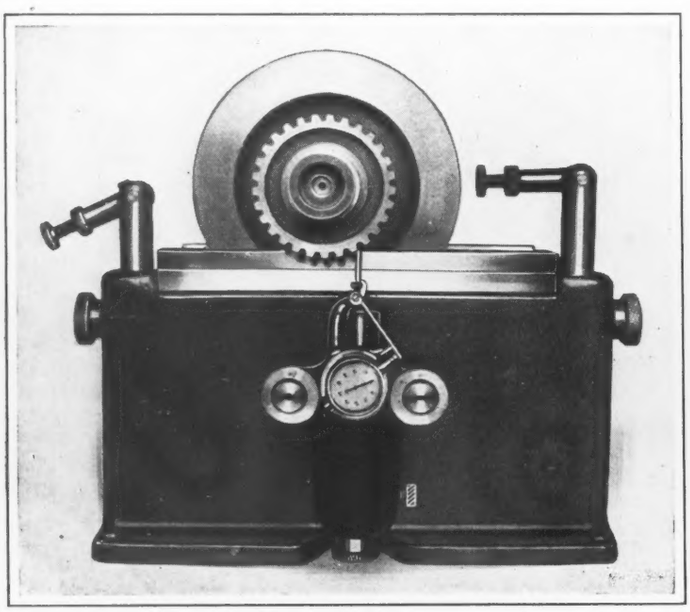


Fig. 4. Front View of Involute Testing Instrument with Gear in Position for Inspection

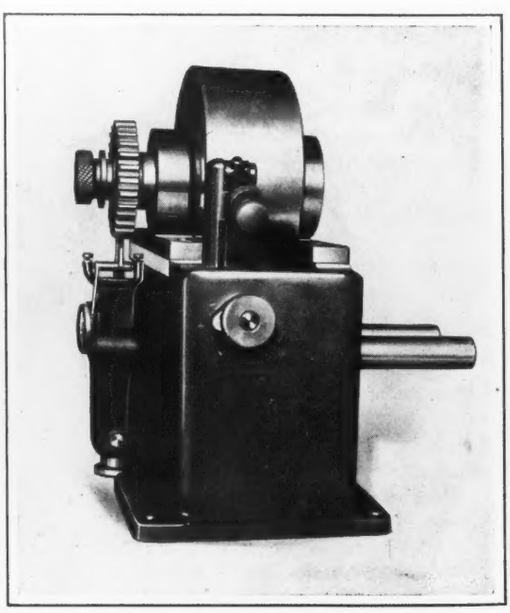


Fig. 5. End View of Instrument, showing Rolling Cylinders, Flat Surfaces, etc.

on which it is free to revolve and move up and down. The pulley is rotated and supported by a small cone-shaped driving burr, located at the rim and as nearly as possible under the point of the downward thrust of the abrasive ring. This pulley-rotating mechanism, as well as the vertical arbor, is supported on a table which can be moved in all directions. The driving burr receives its motion from worm-gearing through a cone pulley, clutch, and universal joints. A patent application has been made for this driving burr.

The machine consists of a heavy column with a wide flange at the bottom, a knee supporting a table, and a head bolted on top of the column which carries the main spindle. On the front end of this spindle there is mounted a pressed-steel chuck which receives an abrasive ring, 12 inches outside diameter, 3 inches deep, and with a rim thickness of 1 inch or more. The spindle runs at about 1500 revolutions per minute. From the sectional view shown in Fig. 2 it will be seen that an adjustment nut in the chuck permits of setting the abrasive ring forward as it wears away, until a thickness of only about $\frac{5}{8}$ inch is left. The entire chuck is readily removed for changing the ring wheel.

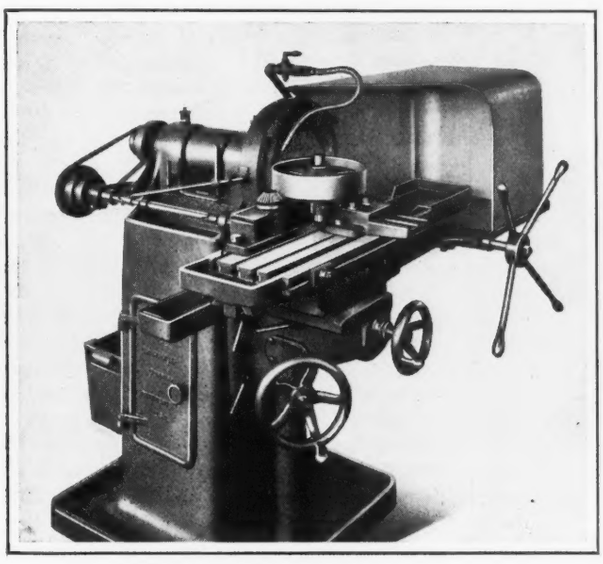


Fig. 1. Graham Grinding Machine for finishing Pulley Faces

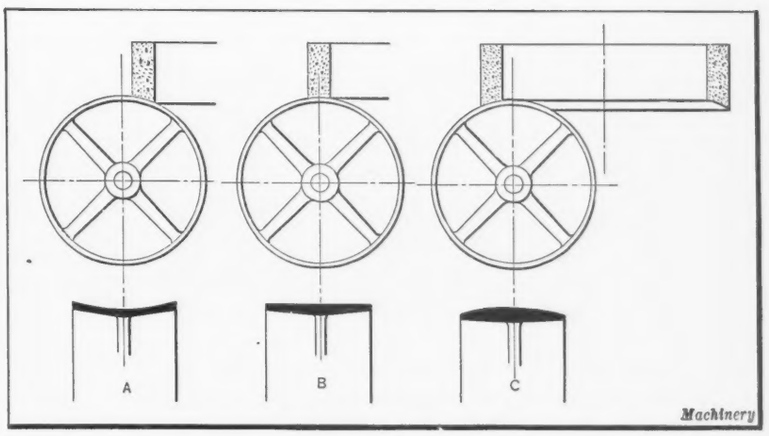


Fig. 3. Diagrams showing the Relative Positions of the Work-arbor and Wheel for Different Styles of Pulley Faces

The spindle is held in taper roller bearings, all end play being eliminated by mounting the rear bearing in a sliding sleeve against which a spring exerts a pressure of about 125 pounds to keep the front bearing tight on its seat. The table is adjusted endwise by rotating a pilot wheel if the machine is used for straight flat work instead of circular. As the machine is intended for wet grinding, the abrasive ring holder is surrounded by strong cast-iron guards, the knee supports a large hood and trough that return the water to the tank, and there is a main front pan that is not shown.

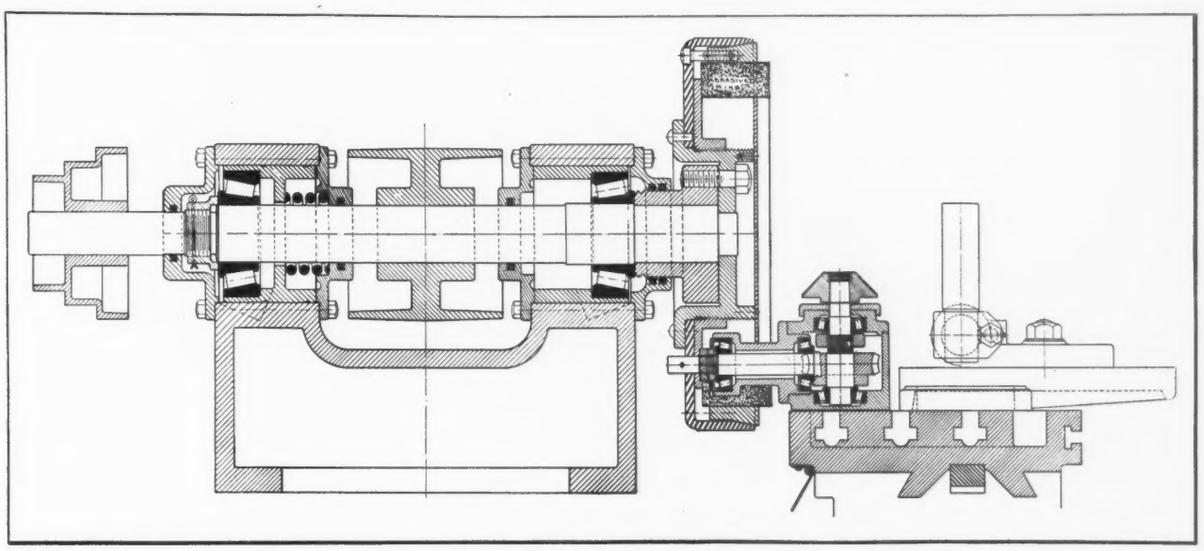


Fig. 2. Sectional View of the Grinding Head, Chuck, Table, and Driving Burr

In operation, the vertical pulley arbor and the driving burr must be brought into the proper relation with the abrasive ring. If the pulley is to have a straight face, the middle of the face must be on a level with the center of the main spindle, and the vertical arbor must be directly opposite the center of the grinding wheel face, as shown at *B*, Fig. 3. If the pulley is to be crowned, the vertical arbor is set a little nearer the center of the abrasive ring, as shown at *C*, and the grinding begins on the inside corner of the ring wheel, which is worn back until the whole face of the wheel becomes concave, and produces a true crown. If the pulley face is to be concave or hollow, the vertical arbor is set on the other side of the grinding wheel face from the center of the wheel as shown at *A*. The abrasive ring has contact across the entire width of the pulley, no matter what shape of face is being ground.

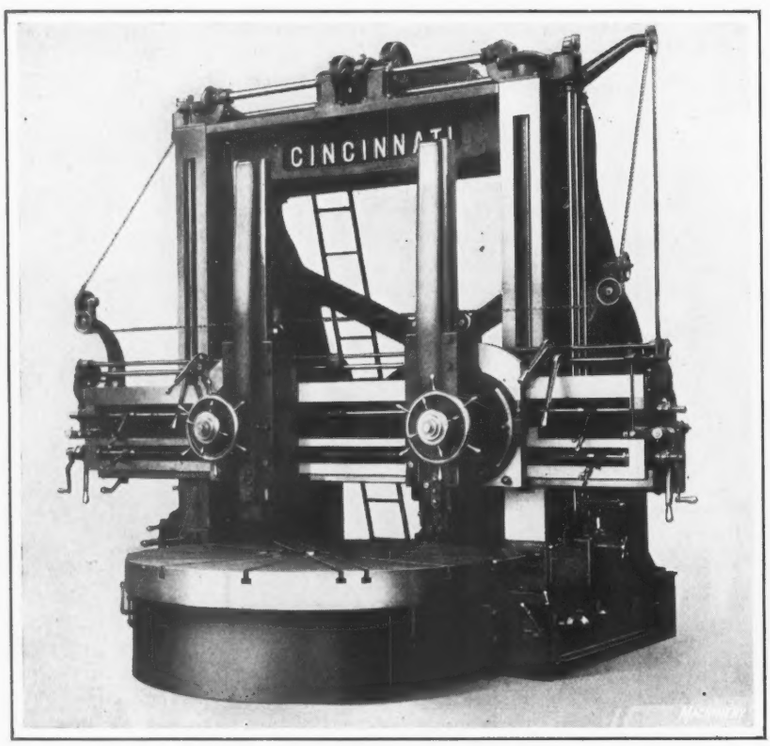
The surface speed of the pulley face ranges from 50 to 250 feet per minute, depending upon the casting, the hardness and grain of the abrasive ring, and the finish required. The pulleys can sometimes be safely put on and picked off

the arbor while running, thus saving the necessity of stopping the driving burr. The burr can be used to drive the pulley in either direction by simply placing it against the inside or the outside of the rim. The machine can handle pulleys of various diameters. It requires about 10 horsepower for driving, and weighs approximately 2000 pounds.

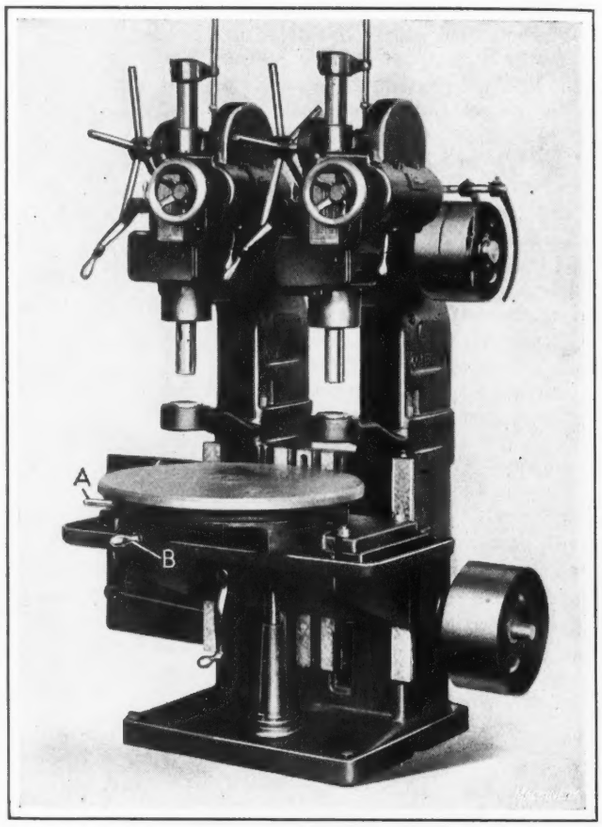
CINCINNATI BORING MILL

The special 8-foot boring mill here illustrated has been recently built by the Cincinnati Planer Co., Cincinnati, Ohio. The pinion that meshes with the bevel gear for driving the table is supported on both sides, and is a separate unit from the drive gear-box. The latter has four speeds when the machine is driven by a variable-speed motor, and nine when a constant-speed motor drive is provided. The motor is mounted on top of the box and geared down to the driving shaft. Speed-change levers for obtaining the various table speeds are located directly at the side of the operator. All gears in the drive box are made of steel, and the shafts are of high-carbon steel. The housings are of extra height, and are bolted, doweled, and tongued to the extension, and tied together at the top by a heavy box arch. An X-brace is also used to assist in keeping the housings firm.

The heads are provided with handwheels equipped with a hand-feed and lock, which allows the operator to feed and lock the heads without exertion. The rams are of extra length, and the steel rack is bolted directly to the rams to allow replacement. The feed and the rapid traverse of the heads are controlled from the side of each head, so that when a head is being used in the center of the table, the control levers are within easy reach of the operator. Handles are also provided to facilitate slight settings of the tools. The feeds are obtained through a gear-box having eight feeds, and a tumbler arrangement which automatically locks itself when placed in the proper position. All controls are so centralized that the operator can reach any lever required. The rail is raised and lowered by means of an elevating device on which there are positive clutches and a friction clutch for safety. A limit stop automatically throws out the clutch when the rail is raised to maximum height.



Cincinnati Boring Mill of Special Design



Colburn Two-spindle Drilling Machine

COLBURN TWO-SPINDLE DRILLING MACHINE

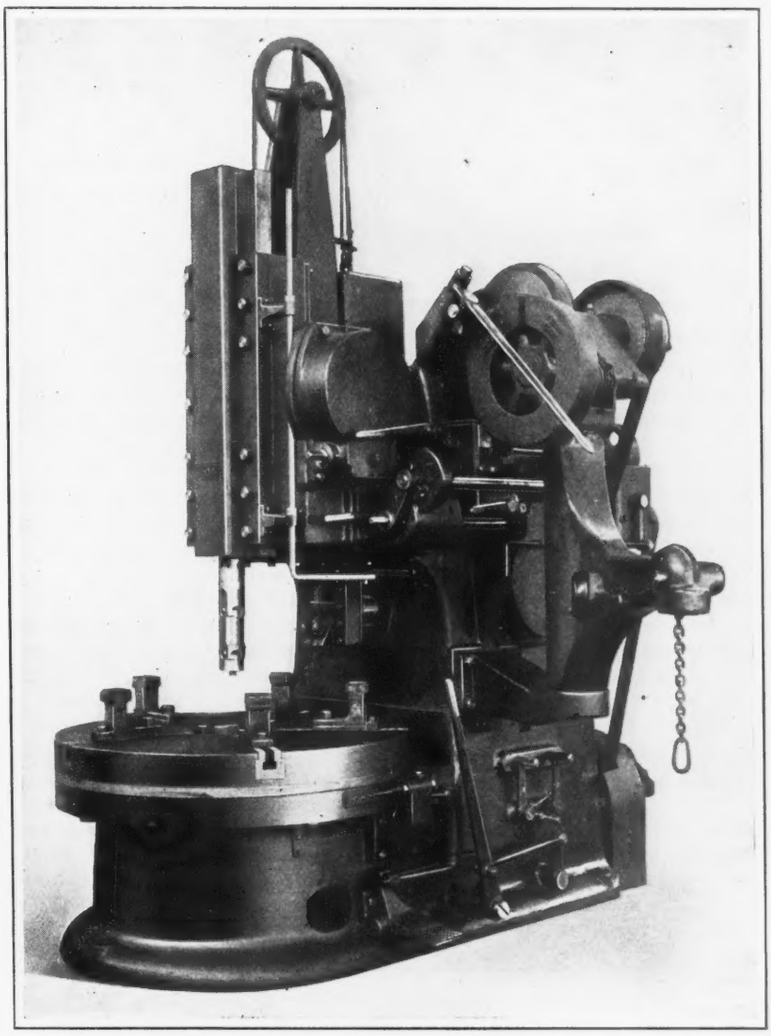
A two-spindle No. 2 heavy-duty drilling machine, built by the Colburn Machine Tool Works of the Consolidated Machine Tool Corporation of America, Rochester, N. Y., which is equipped with steady supports and a special three-station rotating table is shown in the accompanying illustration. This machine was developed for drilling and reaming cast-iron bushings. It will be seen that two heads are mounted on a common column which carries a bracket type of table extending the full length of the machine. The rotating table is clamped to the regular table, and of the three stations, one is for loading, one for drilling, and one for reaming. Lever *A* is operated to release the indexing latch, while lever *B* clamps the table in position after it has been indexed. An automatic trip, together with spring-type counterweights, returns the spindle automatically to the starting position after each operation.

A five-horsepower motor is mounted on a bracket at the rear of the machine for driving, and is geared to a jack-shaft. Each head is driven by belt from this shaft, but the heads are entirely independent of each other and can be operated at different feeds and speeds. The machine has all the characteristics of the Colburn manufacturing-type heavy-duty drilling machines, and is intended for machining duplicate parts in quantities. It is especially adapted for handling a large variety of work requiring a wide range of speeds and feeds. On work where two stations are desired for drilling, a four-station rotating table can be provided instead of the three-station type.

BETTS CAR-WHEEL BORER

A car-wheel boring machine containing a number of labor-saving features has recently been brought out by the Betts Machine Works of the Consolidated Machine Tool Corporation of America, Rochester, N. Y. The features include an automatic chuck and a power rapid traverse to both the boring and facing spindles, enabling the workman to perform all operations quickly and with little manual labor. The boring spindle is of a heavy rectangular section, while the facing spindle has a bearing in a square guide on the under side of the frame, thereby supporting the facing tool close to the cut. There is a vertical adjustment for the facing-tool slide to accommodate various heights of wheel hubs. The power rapid traverse is independent for both the boring and facing spindles, so the rapid traverse may be used on one while a feed is used on the other.

Six feeds are provided for both heads, and these are obtained through selective sliding steel gears which may be changed while the machine is running. In operation, when the roughing cutter is through the wheel, the operator throws the proper feed-lever to instantly start the finishing feed without stopping the table. Two-in-one boring tools can be used to the greatest advantage. The boring spindle is equipped with a counterbalance weight, so that it may be conveniently raised and lowered by hand by means of a crank-handle when a close adjustment is to be made. When the spindle is elevated, this weight enters a chamber in the frame where it is out of the way of the operator.



Betts Car-wheel Borer with Automatic Chuck and Power Rapid Traverse to Boring and Facing Spindles

The automatic chuck is controlled by a reversing friction clutch, which makes it unnecessary to stop or reverse the motor when closing or opening the chuck. When the clutch is thrown in, the table starts to rotate and the jaws move toward the center, gripping the wheel with the full driving force of the motor. The heavier the cut, the tighter the jaws grip. When the bore is finished, the table is stopped by means of a band-brake operated through a foot-treadle, and the clutch is then thrown in the reversing direction, to cause the jaws to open instantly without stopping the motor. By means of this band-brake, the operator may also stop the table and caliper the bore of the wheel without loosening the grip of the jaws on the wheel. Four table speeds in geometrical progression are obtained through hardened steel grinding gears in the base of the frame, which run in a bath of oil.

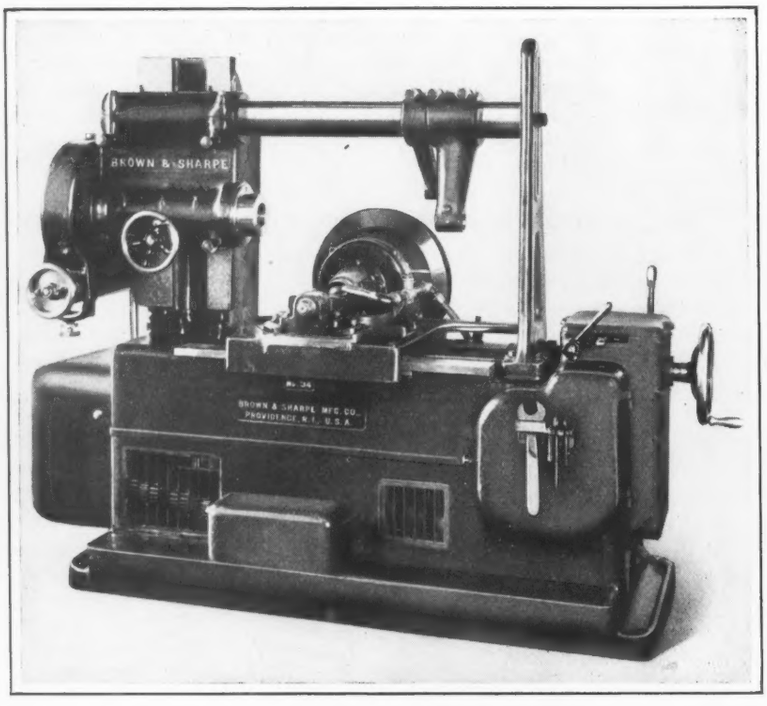
Either a mechanical or pneumatic hoist may be supplied. When a mechanical hoist is furnished as illustrated, it is driven by belt from the main driving shaft, so that only one motor is required on the machine. All control levers are located on the right-hand or operating side where they are always within easy reach of the workman. This machine has a capacity for boring wheels from 10 to 42 inches in diameter, and can also be furnished without the facing head for finishing hubs.

BROWN & SHARPE SPUR GEAR HOBBER

A No. 34 gear-hobbing machine designed for producing gears of the spur type only, has just been added to the line of hobbing machines built by the Brown & Sharpe Mfg. Co., Providence, R. I. From the illustration it will be seen that the new machine is quite similar in construction to the No. 44 spur and spiral gear hobbing machine which was described in November MACHINERY. However, there are a number of important differences, and it should be noted that the No. 34 machine has fewer parts. For instance, as this machine cuts only spur gears, the differential is eliminated, and the feed-case mechanism is simplified, because it is not necessary to provide for reversing the feed or the direction in which the hob rotates. The lead change-gears which constitute quite an important item on the No. 44 machine have been entirely done away with on the No. 34 hobber. The well-known B. & S. method of using split washers on the studs of change-gears is used on this machine.

One of the greatest differences between these two machines is the hob slide. The No. 34 machine requires only 10 degrees adjustment of the hob-spindle to take care of the hob angle of lead. Naturally on the No. 44 machine, which cuts spiral gears, the angle of setting must be considerably greater, in order to take care of this class of work. The difference in the amount of hob swivel adjustment required permits a much simpler arrangement for the drive. On the No. 44 machine the drive comes through a large bevel gear on the center line of rotation of the hob swivel, whereas, on the No. 34 machine the drive comes through a vertical shaft at the rear.

A much larger balance wheel can be used on the No. 34 hobber, because it is not necessary to swing it over the hob slide ways. Other features of the No. 44 machine such as the heavy over-arm and outboard support, index worm and wheel, constant-speed drive friction pulley, hob lubricant pump, etc., are also furnished. The No. 34 machine is in-



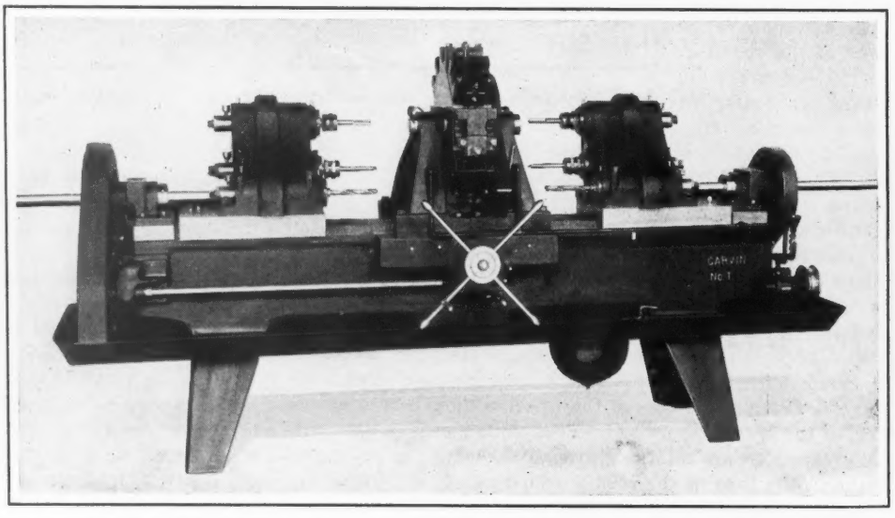
Brown & Sharpe Spur Gear Hobbing Machine

tended for hobbing gears up to 18 inches pitch diameter and 3 diametral pitch in cast iron and 4 diametral pitch in steel. The machine is self-contained, and can be belted from a main lineshaft direct to the friction pulley without an intermediate countershaft. Because of this arrangement, the machine can be readily adapted for a motor drive, and when so equipped the motor is geared direct to a friction gear on the main driving shaft. The motor is mounted on a bracket at the rear of the machine, where it is out of the way and yet readily accessible. The floor space required at right angles to the hob-spindle, with the covers open, is 103 inches, and parallel to the hob-spindle, with the covers open, 50 inches. The machine weighs about 6030 pounds.

GARVIN DUPLEX HORIZONTAL DRILLING MACHINE

A special duplex horizontal drilling machine known as the No. 1-S, which is arranged for drilling, boring, and reaming automobile steering knuckles has recently been developed by the Garvin Machine Co., Spring and Varick Sts., New York City. With the exception of the three-spindle heads and the squirrel-cage type of work-holding fixture, which are clearly shown in the accompanying illustration, this machine is of the standard design made by this company. With this equipment, three different pieces of work are operated on at the same time, a ¾-inch hole being drilled in one piece while the same hole is bored to 27/32 inch on another piece and finish-reamed to ⅞ inch on a third piece.

The heads are fed automatically toward the work, but are returned by rotating the pilot wheel on the front of the machine. The fixture is then indexed to the next place, and the feed again thrown in. One steering knuckle is completed every forty seconds. Each head is driven independently by a 7½-horsepower motor attached to the rear of the corresponding end of the bed, which makes a compact drive. The power is transmitted from the motors through spur gears to the main driving shaft in the heads. All gears are adequately protected by guards. The work is continuously flooded with lubricant supplied by the pump at the front of the machine on the right-hand end.



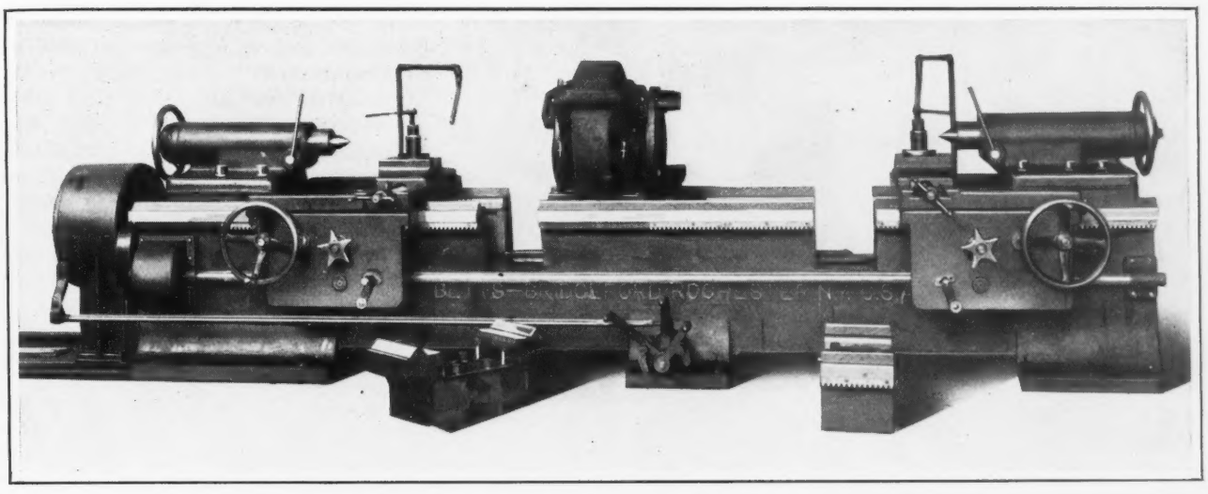
Garvin Duplex Horizontal Drilling Machine arranged for drilling, boring, and reaming Steering Knuckles

BETTS JOURNAL-TRUING AND AXLE LATHE

The improved combination journal-truing and axle lathe just developed by the Betts Machine Works of the Consolidated Machine Tool Corporation of America, Rochester, N. Y., is shown in the accompanying illustration. This machine is provided with two carriages for turning outside journals with the wheels mounted on the axle, the gaps in the bed being used for swinging the wheels. These gaps have finished surfaces to receive the blocks shown on the floor, which are inserted in the gaps when the machine is to be used as a regular axle lathe. With the blocks inserted, the carriages have ample travel for turning both the wheel seat and the journal fit, finishing the fillets of the axle, and burnishing.

The center driving head is of the opening type, which allows axles with wheels mounted to be placed on the centers. The large driving gear is made in halves, with coarse-pitch and wide-face teeth. This gear rotates in two large bronze bearings, one on each side of the center. The pinion meshing with this large gear runs in oil and is mounted on a shaft located in the center of the bed and driven from speed-change gears in the left-hand end. Three speed changes are available through hardened steel sliding gears, these speeds being changed from the center of the machine. The carriages are driven from a splined feed-rod through gears which give a range of four feeds, these feeds also being changed from the center of the machine.

When the machine is driven by a single pulley or an alternating-current motor, the drive is through a friction clutch and an automatic brake, which are also operated from the center of the machine to give the operator complete control from his normal working position. When driven by a direct-current motor, a dynamic brake in the controller is used for quick stopping, being operated by means of a con-



Betts Journal-truing and Axle Lathe from which Sections of the Bed can be removed to swing Wheels

veniently located push-button. The lathe is built to swing either 45 or 55 inches in the gaps, and axles of various lengths can be accommodated, as both tailstocks are adjustable along the bed.

CLEVELAND AUTOMATIC THREE-SPEED HEAD

A three-speed spindle head which has a number of interesting features has been designed for use on the automatics built by the Cleveland Automatic Machine Co., Cleveland, Ohio. When equipped with this head, the machine may be driven by a single-pulley belt or by a constant-speed motor. The spindle speeds are two forward and one reverse and they are obtained with one set of change-gears. All three speeds are automatically controlled by operating the clutch levers seen in Fig. 1, the movements of which are governed by cams on the drum shown. The clutches which these levers control are arranged to bring the various combinations of gearing into position to give the desired speeds. The gears and bearings are lubricated by a splash system inside the gear-box.

Four sets of change-gears are furnished with each machine to give forward speeds ranging from 137 to 751 revolutions per minute and a reverse speed of 265 revolutions per minute. The desired change-gears are easily placed in position, as will be apparent from Fig. 2 which shows the opening in the guard. The entire machine is driven from the single pulley seen in this illustration.

The feed mechanism is driven at a constant idle-motion speed, which is regulated by raising or lowering the friction roll, as in previous designs. The power for the feed is transmitted from the single pulley through a series of bevel gears and a driving shaft mounted along the bed of the machine and connected with the feed mechanism by means of a silent chain. The oil-pump is also driven from this shaft. The operation of the machine is simple, starting and stopping being accomplished by means of the lever shown in Fig. 2.

BEAMAN & SMITH DRILLING, BORING, TAPPING AND MILLING MACHINE

The main features of a new line of floor-type horizontal-spindle drilling, boring, tapping, and milling machines recently developed by the Beaman & Smith Co., Providence, R. I., are the centralized control and the drive for the spindle. With the centralized control all speeds, feeds, and adjustments can be obtained from one position. The motor for driving the spindle as well as the intermediate driving members is mounted on the head itself, with a view to reducing torsional strains to a minimum and to applying the power as close as possible to the cutters. This line of machines is built in various sizes with the spindle 3, 3½, 4, 5, 6½ and 8 inches in diameter. The particular machine illustrated is the 8-inch size, which has a 4-foot feed.

There are power boring feeds and quick power movements in either direction, and there are also hand adjustments.

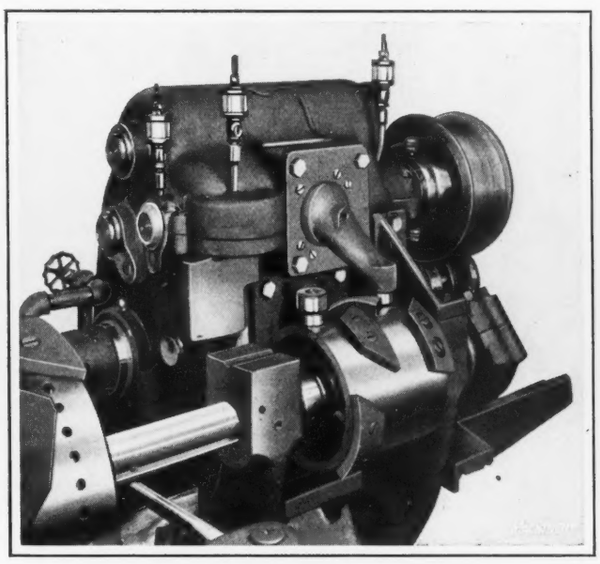
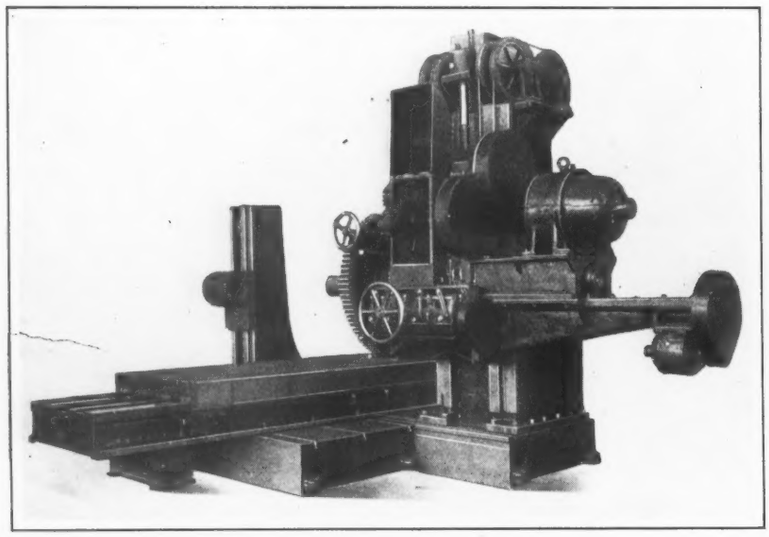


Fig. 1. View of Three-spindle Speed Head for Cleveland Automatics

Fig. 2. View of Head, showing the Change-gears, Driving Pulley, etc.



Beaman & Smith Horizontal-spindle Drilling, Boring, Tapping, and Milling Machine

The boring feeds range from 0.006 inch to 2.72 inches per spindle revolution, there being eight changes in geometrical progression. The saddle which carries the spindle has quick power vertical adjustments on the column, and milling feeds can be provided. The vertical travel of this member is 44 inches. The spindle speeds range from 1¼ to 80 revolutions per minute in geometrical progression. The motor is of 15 horsepower capacity and of the adjustable-speed type, with speeds ranging from 400 to 1600 revolutions per minute. The spindle quill runs in conical boxes of hard bronze, with provision for taking up wear, while longitudinal wear may be compensated for by taper boxes. End thrust is taken by ball bearings.

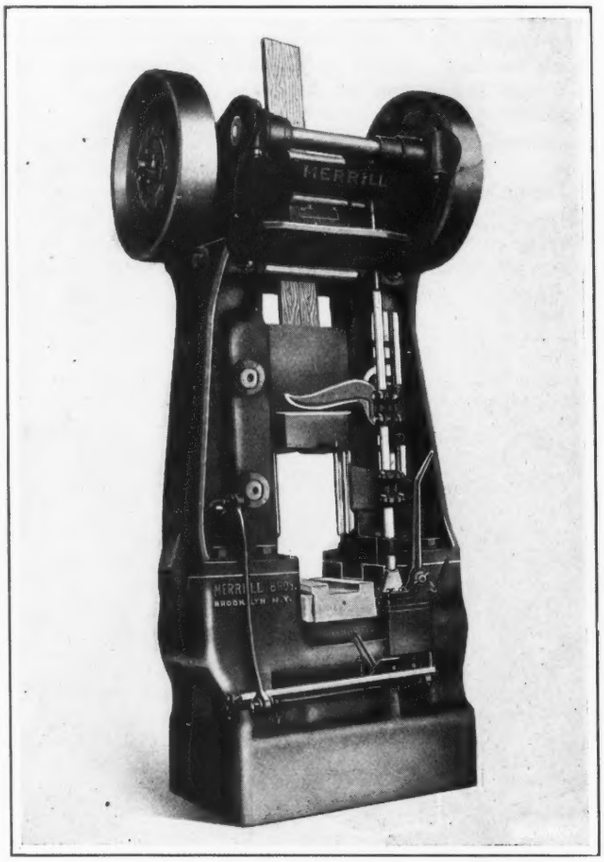
The table is 4 feet wide by 10 feet 6 inches long, and is equipped with a quick power travel along the bed, as well as hand adjustments. Milling feeds can also be provided for this member if required. The bed has adjustments along the platen parallel with the spindle, so as to bring work up to milling or facing cutters when these are attached to the faceplate gear. The outer support also has adjustments along the platen and vertical adjustments to correspond with the spindle. Scales and micrometer dials are provided wherever necessary to insure accurate alignments. The 8-inch machine weighs approximately 72,000 pounds.

MERRILL BOARD DROP-HAMMERS

There are a number of interesting features in the line of improved board drop-hammers that is now being introduced to the trade by Merrill Bros., Maspeth, Queens Borough, New York City. In the lifting mechanism, roll rockers have been substituted for the sliding boxes used in the previous design. The direct horizontal pressure against the board is maintained the same as with sliding boxes, and the rockers have the advantage of a better support for the roll pressure and the belt pull. To maintain the parallelism of the rolls, a compensating eccentric has been introduced in one of the eccentric sleeves, which can be adjusted without removing any of the lifter parts. The hammer can be arranged in a few minutes to use either a very thick or a very thin lifting board by changing the roll eccentric bushing. The construction is such that when the friction bar falls the rolls are practically locked, which permits the use of a light friction bar, rolls the board more nearly straight, and obviates excessive wear near the point of pick-up. The main roll bearings are ring-oiled from four large pockets, and sliding bearings (where the pressure is high but the movement small) are lubricated by means of felt pads soaked in oil from reservoirs.

The friction rod is claimed to be absolutely straight, and has an eye at the upper end for attachment to the eccentric lever. The roll-releasing lever lifts the friction bar to its seat without shock or jar, permitting the hammer to run at about as high a speed as the lifting board will stand. The lever is so constructed that the leverage shortens as the bar is raised. The under surface of the lever is curved, so that the pressure against the ram is constantly in a vertical direction, which practically eliminates kick-back on the roll-releasing mechanism. The adjustment for length of stroke can be positively and easily made. Both seats for the upper and lower positions of the rod are in one assembly, and the entire mechanism may be removed after releasing two vertical guide bolts. Non-metallic plates are spaced under the stop seats to take the shock of the falling rod, and these plates can be varied in thickness to enable the rod to be brought to rest at different heights at its upper and lower positions. The clamp for holding the ram suspended is adjusted in conjunction with a special treadle.

There is a provision for truing up the vees of the uprights when they become too badly worn to make accurate forgings. This feature is taken care of by adjustable and reversible ram guides which are fitted to the upright frames. Besides being reversible, the guides have double vees to prolong the life of the wearing surfaces. The face of the ram can be squared up from the right and left with the face of the shoe, by adjusting both the bottom and top guide wedges. A simple and positive device has been attached to the treadle which makes it impossible to trip it except by placing the foot on a pad about 6 inches square. This pad



Merrill Improved Board Drop-hammer

can be quickly adjusted from right to left to suit the operator, and it can be removed when not required. The die adjustment from front to back is accomplished by means of a double-taper insert in the top of the forged steel shoe opposite the die key. This hammer is built in sizes ranging from 600 to 5000 pounds, falling weight.

AJAX DROP-LOCK FOR FORGING MACHINES

A new stop-motion device called the "rocker type drop-lock" has recently been developed by the Ajax Mfg. Co., Cleveland, Ohio, and adopted as standard equipment for that company's new model bolt-heading upsetting forging machines. Those familar with a stop-motion forging machine know that the slides remain at rest until the hot stock is located in the impression in the stationary die and the machine is tripped. In such operator-controlled machines, the nearly universal method of bringing the slides into action is by having a clutch in a revolving gear or flywheel engage directly in the end of the crankshaft, which is at rest. This drop-lock device is set to eliminate all shock in picking up the crankshaft at full speed.

The crankshaft *A*, Fig. 1, with the pitman *B* attached, is in idle rotation when the slides are at rest, the wrist-pin

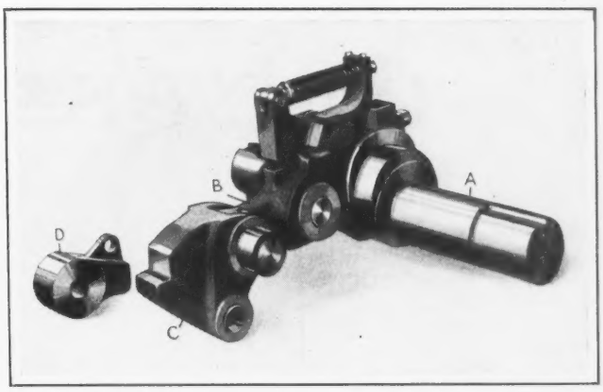


Fig. 1. Rocker-type Drop-lock invented for Use on Ajax Upsetting Forging Machines

when engaged, and the slides are thrown into motion without shock for as many strokes as desired. Upon removing the foot from the treadle, the lock is disengaged and the slides come to rest at their extreme back travel.

This device is similar in principle to the slide-block type of drop-lock which it replaces, but it is a decided improvement over the old design, owing to the shortness of the lock, the increased engaging area, and the smooth action.

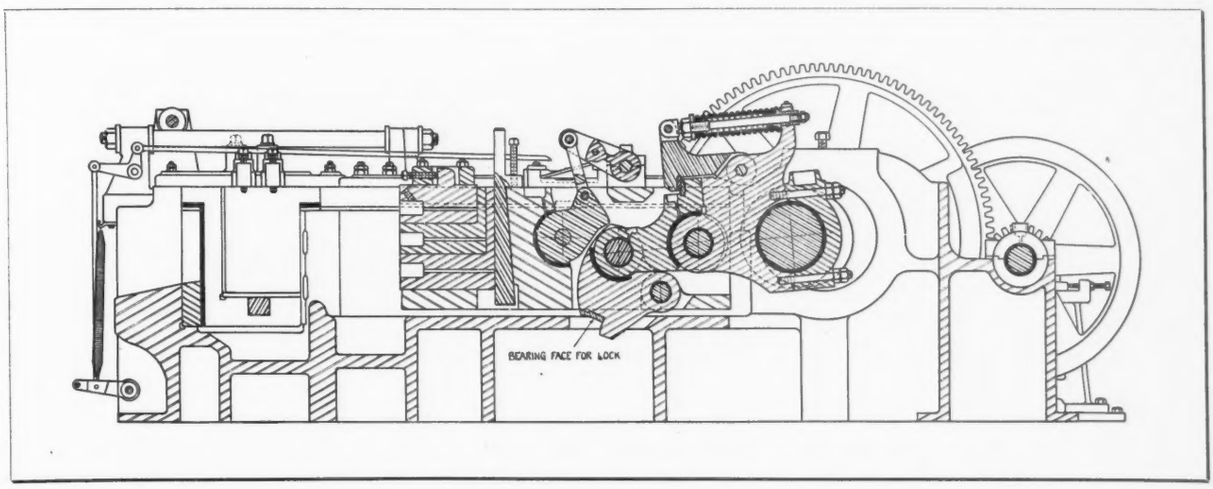


Fig. 2. Sectional View of Forging Machine, illustrating Position of Drop-lock on Idle Strokes

end of the pitman being carried by an oscillating rocker *C*, fulcrumed at the bottom of the header slide. While the machine is idle, this rocker swings free under the drop-lock *D*, as shown in Fig. 2, but when the treadle is depressed, the lock drops on the upper surface of the rocker and rides on this surface until the rocker reaches its extreme back travel, at which time the lock falls into engagement as shown in Fig. 3. Since this occurs just as the crankshaft passes over its back dead center, the velocity of the reciprocating and oscillating parts is practically zero

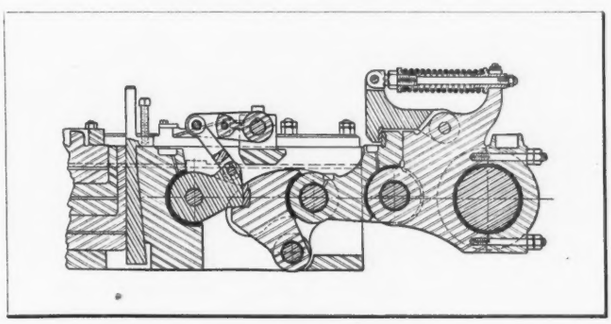


Fig. 3. Drop-lock engaged, with the Rocker Pitman and Crankshaft in Constant Motion

Its relatively light weight eliminates the necessity of the counterweight and timing lock formerly employed. The new device is protected by a patent granted to the inventor, J. R. Blakeslee, president of the Ajax Mfg. Co.

BOLENDER GEAR GRINDING CHUCKS

The Bolender chucks, designed to hold gears, while grinding the bore, in such a way that the bore will be produced concentric with the teeth, are now being manufactured by the City Engineering Co., 4th and St. Clair Sts., Dayton, Ohio. The chucks may be equipped with either three or five jaws which, for spur gears, are each used with a hardened and ground steel pin which is seated between two teeth of the gear, as illustrated in Fig. 1. In some instances, special retaining devices are used to position the pins approximately, so the operator does not have to locate each one.

Spur gears are easily held concentric within 0.001 inch, this accuracy being obtained with practically no attention on the part of the operator. The back of the work seats against three locating points. The jaws are operated radially to and from the work by turning the ring seen at the back of the chuck in Fig. 2, around which bushed holes are provided to receive a bar for revolving it. One chuck can be

BROWN & SHARPE MACHINES

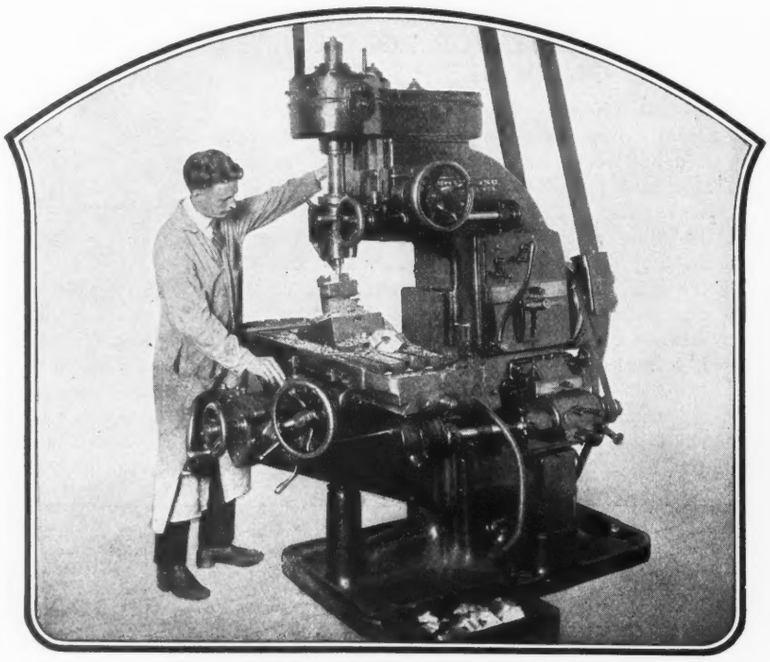
BROWN & SHARPE PRODUCTS

Milling Machines
Grinding Machines
Gear Cutting Machines
Screw Machines
Machinists' Tools
Cutters and Hobs

WORLD'S STANDARD FOR QUALITY

Accuracy

Lasting accuracy is typical of all Brown & Sharpe Products. Their enduring precision is the result of care in workmanship and sturdiness in design. The mechanical world knows that Brown & Sharpe Products retain their accuracy throughout years of hard usage. And remember that lasting accuracy depends on strength of design as well as skillful workmanship.



Brown & Sharpe No. 2 Vertical Handy—Accurate—Rugged

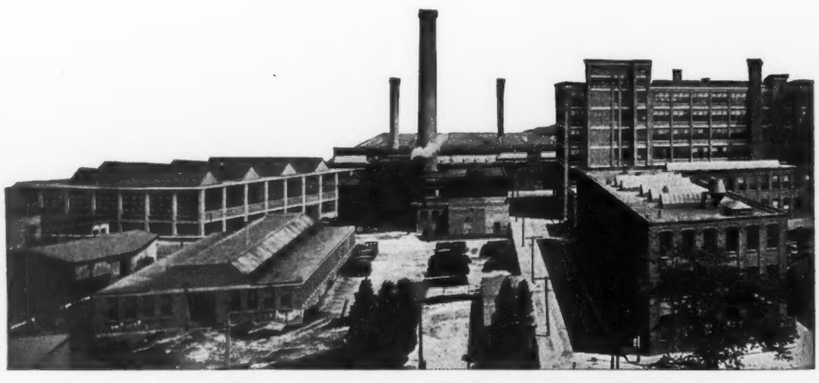
In Brown & Sharpe Machines, accuracy and strength go hand in hand. Our No. 2 Vertical Spindle Milling Machine, for example, is accurate enough for the finest tool and die work and strong enough to stand the grind of heavy production.

On this machine, the spindle mounting clearly illustrates how strength is combined with accuracy. Long bearings keep the spindle in perfect alignment, insuring extreme accuracy on fine work. During heavy cuts, these same long bearings are of obvious advantage in resisting the effect of heavy side thrusts.

Strong, accurate, handy, this No. 2 Vertical meets a real need of the average shop. Pick out the work in your shop which could be milled to advantage on this type of machine. For further details write for our General Catalog No. 137.

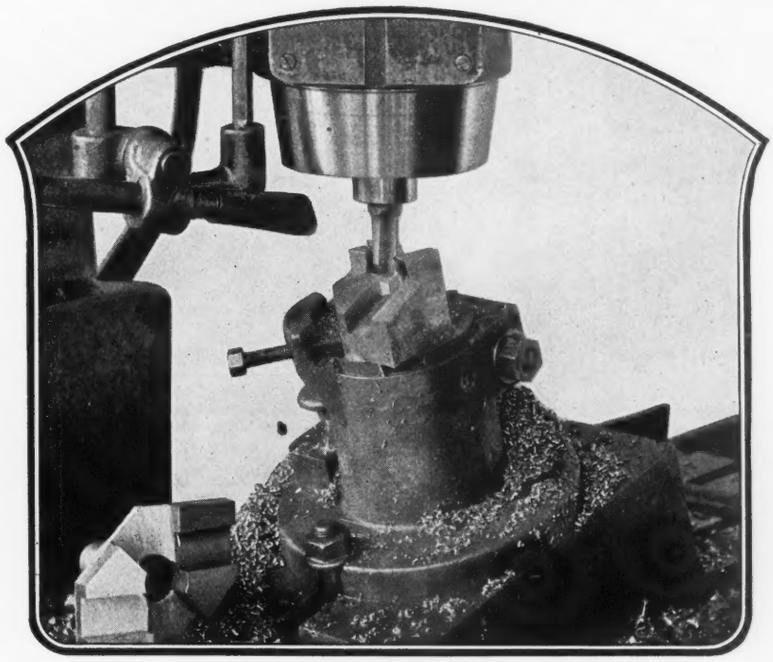
BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

This catalog lists our entire line of Milling Machines — five styles and over 30 sizes. Look through this catalog carefully. Among the machines listed, there may be one or more which will meet your requirements. Write today for catalog No. 137



32 Acres of Floor Space—The BROWN & SHARPE PLANT

BROWN & SHARPE CUTTERS



Once you have seen the chips fly as the metal disappears under the whirling teeth of a Two-Lipped End Mill, you will always use one when you have rapid slotting to do. Brown & Sharpe Two-Lipped End Mills are made in a score of sizes ranging from ¼" to 1½" in diameter. Order one from your dealer today.

For Rapid Slotting Use Brown & Sharpe Two-Lipped End Mills

Brown & Sharpe Two-Lipped End Mills are especially suited to the rapid milling of deep slots from solid steel or iron. These cutters will mill a slot in a single rapid cut where previously it was necessary to drill a series of holes and make several cuts. By running Two-Lipped End Mills at a high surface speed, the chips are thrown clear of the cut, clogging is prevented, and the cutter advances rapidly and uniformly. A depth of cut equal to one-half the diameter of the mill can usually be taken from solid stock. If you have much slotting to do, use these Two-Lipped End Mills—the results will surprise you.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

Our No. 28 Catalog describes over 45 styles and 3000 sizes of cutters—a style and size for every milling and gear cutting requirement. Send for a copy of this catalog; look through the cutter section and pick out the cutters you need. Write today for your copy of Catalog No. 28.

PROVIDENCE, R. I., U. S. A.—90 Years of Experience

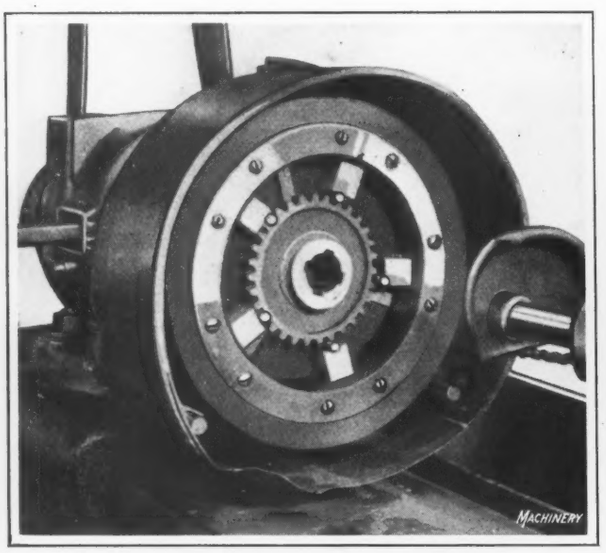


Fig. 1. Bolender Chuck arranged for holding a Spur Gear while grinding the Bore

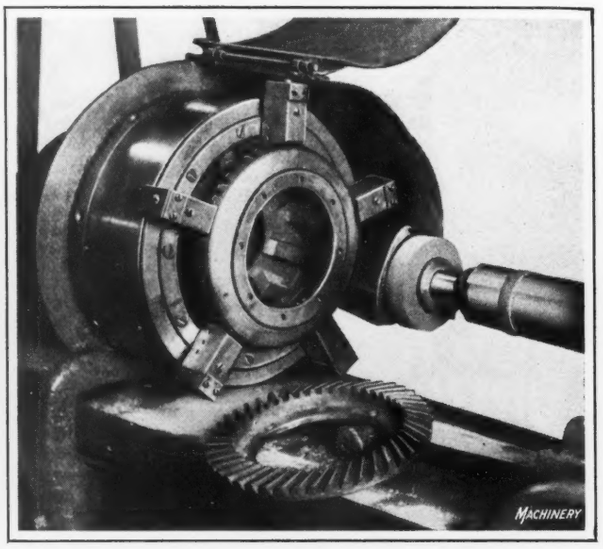


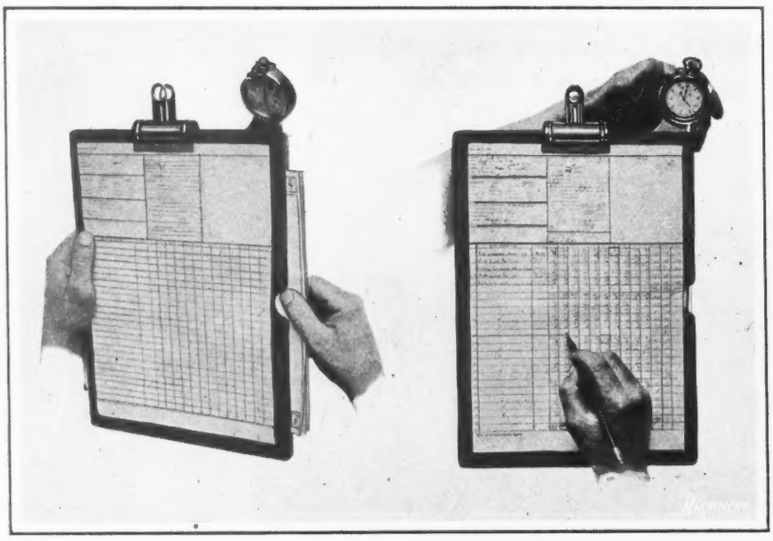
Fig. 2. Special Jaws provided on the Gear Chuck for holding a Spiral-bevel Ring Gear

made to accommodate a large variety of work by simply substituting different sets of jaws, and only a few minutes' time is required to change from one size of gear to another. When this is done, the chuck need not be retrued, it being simply necessary to insert the proper set of jaws and use the required size of locating pins.

Special jaws may be provided for various work. In Fig. 2 is illustrated a set-up in which the chuck is being used for holding spiral-bevel ring gears. For chucking steering-gear worms on the outside diameter, special extension jaws are used. There is also an attachment made for chucking cluster gears true with the pitch circle. These chucks are oil-, water- and dust-proof.

HOUGH TIME-STUDY BOARD

The Hough time-study board, which is designed to facilitate the time study of machine operations, is being manufactured by the Stein & Ellbogen Co., 31 N. State St., Chicago, Ill. This board provides a convenient writing surface for the record blanks, and holds the time-study watch in such a position that it can be readily operated by the left hand while the board is supported by the left arm, leaving the right hand entirely free for marking down figures. Convenient space and storage is provided for all data relevant to the work in hand. The movable clip enables the operator to shift the record blank on the board, clip it at the top or on either side, so as to have the sheet always in the most convenient position. The watch is held securely in the best position for operation, and is protected against breakage. Because of the angle at which the watch is held, there is no glare from the watch face, which insures visibility and assists in making accurate readings. The construction is such that warping is not likely to occur.

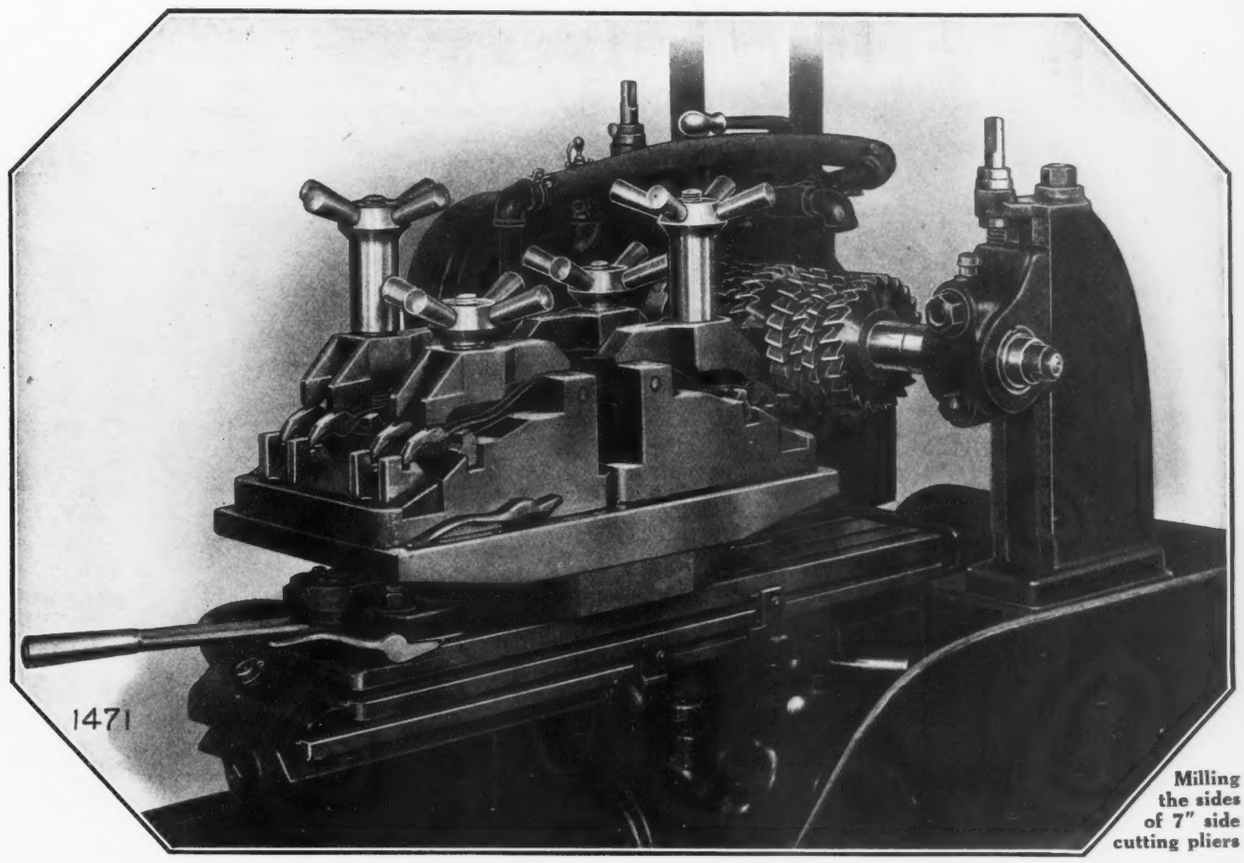


Hough Time-study Board

WATSON-STILLMAN HYDRAULIC STRAIGHTENING PRESS

A rapid-working hydraulic press designed primarily for straightening camshafts, crankshafts, and automobile front axles, but which may also be used for other straightening operations and bending or forcing, is being introduced on the market by the Watson-Stillman Co., 192 Fulton St., New York City. This is a self-contained unit driven by an individual motor and requiring no auxiliary water supply. The machine is under the control of the operator, both as to speed and pressure, by means of a valve operated either by hand or by a foot-lever. The pump is so arranged that the movement of the press ram through the idle portion of its stroke is rapid, and the change from low to high pressure for the actual straightening operation is automatic. A feature of importance is the fact that the whole table can be removed, leaving an open-jaw forcing press for almost universal shop use in mandrel forcing, broaching, force fitting and assembling, etc.

Hydraulic pressure is used only for the pressure or downward stroke of the ram, the return being accomplished by the application of a counterweight within the frame. The frame is a steel casting with a copper-lined cylinder bolted and keyed to it, and the ram is made of high-carbon steel. The pump body is bronze; the plungers are made of tool steel and hardened, and are packed with hemp under bronze glands. The pump valves are made of monel metal, and are of the metallic-seated type. The ram has a positive stop to prevent overstroke. The illustration shows the press equipped with a slow-speed motor and single reduction gearing to the pump shaft, but a high-speed motor with compound gearing to the crankshaft may be supplied. When desired, spring centers can be



Milling the sides of 7" side cutting pliers

SERVICE THAT SAVED

Production was increased 40%—from 1800 to 2500 pieces per hour, using the index base method of Milling and the CINCINNATI 24" Plain Automatic.

A typical example of our Engineering Service:

1. We asked for blueprints and samples of the work.
   (Send us your parts and blueprints.)
2. We submitted our recommendations in the form of a complete estimate, including time studies and sketches.
   (Have you ever used our service?)
3. The above equipment was designed, built and installed by our engineers.
   (We can tell you of many other profitable installations.)

Your production may be increased or the quality of your product improved through the use of CINCINNATI Automatic Millers.

(The Automatic Millers have dog controlled, intermittent feed, relieving the operator of all labor but that of loading and removing the finished work.)

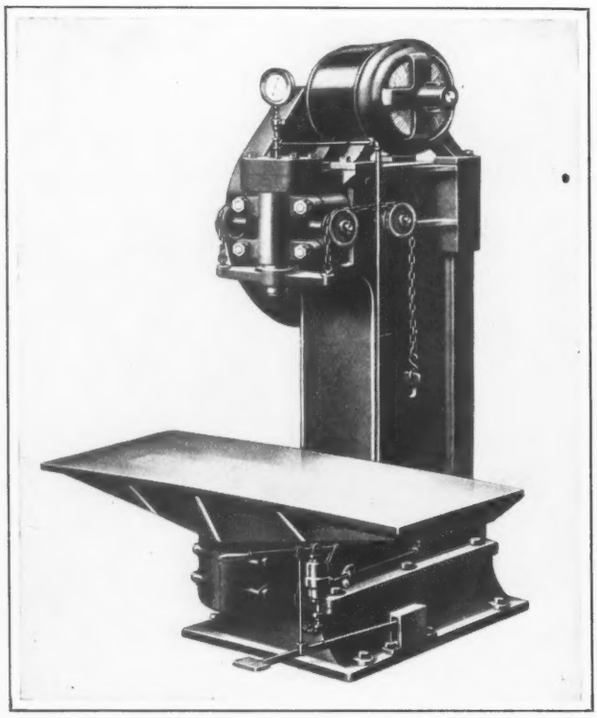
KEEP IN MIND

Not only do we build several types and sizes of Automatic Manufacturing Millers, but, in addition, we offer you a complete line of Knee and Column Type machines (both Cone and Single Pulley Drive), in all, 38 types and sizes. Let us help you select the *right* machine for your particular job.

Send for special folder describing these machines.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI *Established 1884* **OHIO, U. S. A.**

CINCINNATI MILLERS

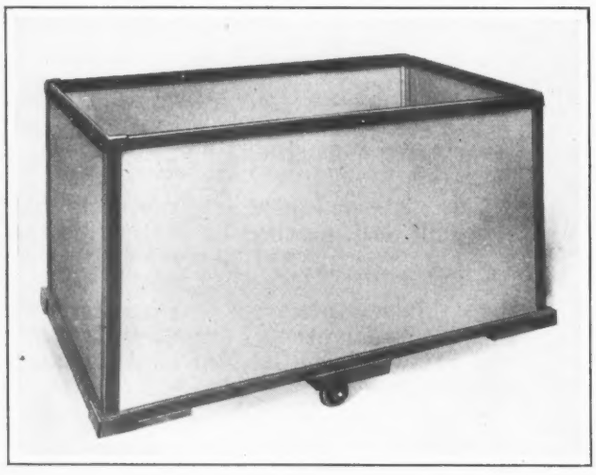


Watson-Stillman Rapid-working Press for Bending, Straightening or Forcing Operations

furnished for holding the work to be straightened. These centers are adjustable for different lengths of work and their position on the table may also be adjusted.

HASKINS "ARMORED" TRUCK

A truck constructed of veneered steel is now being placed on the market by the R. G. Haskins Co., 520 W. Monroe St., Chicago, Ill. The material consists of a wood core with

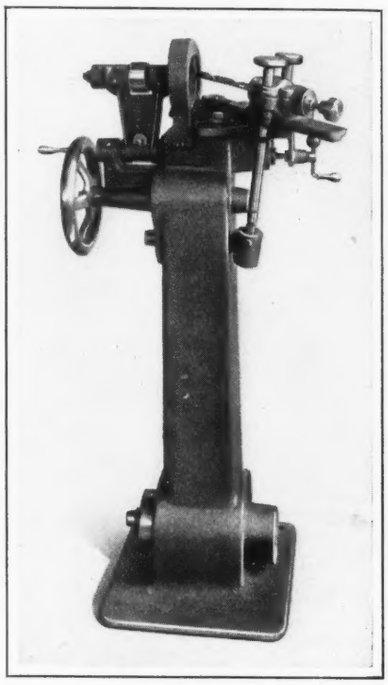


Haskins Truck constructed of Steel-veneer Sheets

sheet steel on both sides to give smooth surfaces and to insure strength without heavy weight. All edges are further protected by angle-irons or steel strips.

OLIVER DRILL POINTER

An addition to the line of drill sharpening equipment built by the Oliver Instrument Co., 1410 E. Maumee St., Adrian, Mich., is shown in the accompanying illustration. This machine is a No. 2 drill pointer, having a range for from No. 60 to ½-inch two-fluted drills. As in the larger-sized machines built by this concern, the drill point is produced automatically by passing the wheel across the point of the drill while the drill is turning, and at the same time feeding the wheel into the drill. The feed is accomplished by means of a cam and spring, and results in uniformly increasing the angle of point clearance as the web is approached. The operator sets the drill in the correct relation to a gage. Only one setting is required for grinding both lips, and for this reason both must be the same length.

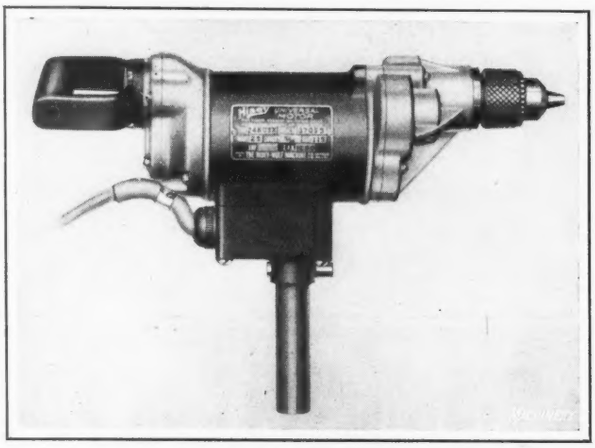


Oliver Small-sized Drill Pointer

The grinding wheel is driven by a motor in the base of the machine, while the mechanism is operated by means of the handwheel which is mounted on a crankshaft. Since this shaft is hand-driven, the pulley, pinion, gear, and clutch of the power-driven machines are omitted. Also, because the machine is designed for grinding only two-fluted drills, the nest of change-gears and the shifter mechanism required in the Nos. 4 and 5 models, designed for grinding three- or four-fluted drills, are not needed. A universal or swivel carriage makes it possible to grind points to any desired angle. The weight of the machine, with standard equipment, is about 315 pounds.

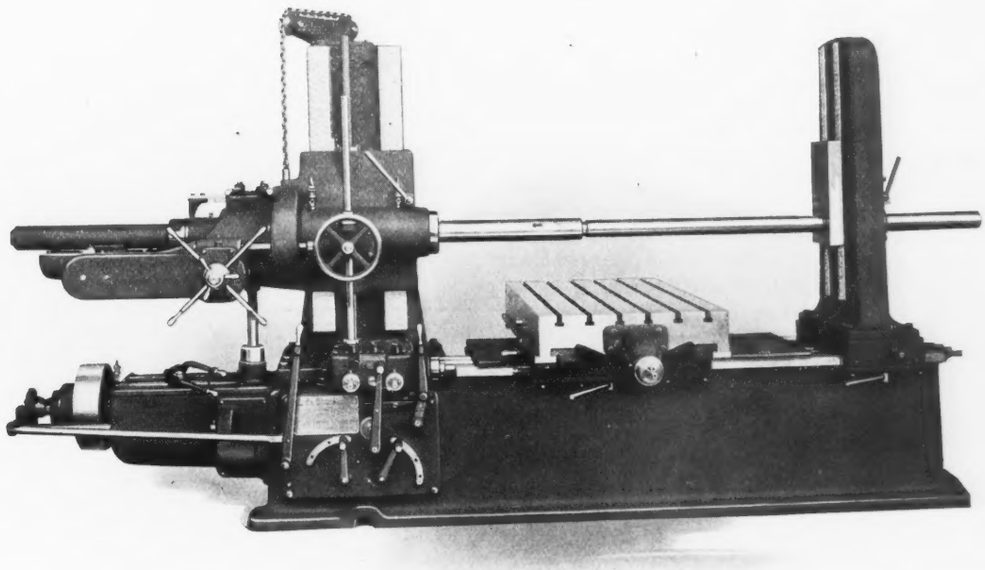
HISEY SIDE HANDLE ELECTRIC DRILL

A 5/16-inch capacity portable electric drill equipped with a side grip handle in which a patented switch is located, has just been brought out by the Hisey-Wolf Machine Co., Cincinnati, Ohio. This tool is supplied with a universal motor for operation on alternating current of 60 cycles or less, and direct current of the same voltage. A quick cable connector permits cable repairs and renewals to be made without dismantling the drill. Ball bearings are supplied for every turning member and all parts are adequately lubricated. A Jacobs drill chuck is furnished, and a grinding attachment with a 4½- by ½-inch wheel may also be supplied. The weight of the drill is about 12 pounds.



Hisey Portable Electric Drill with Side Handle

Quality Must Be Paramount—
We Do No Trading on Past Reputation



The Quality of the

"PRECISION"

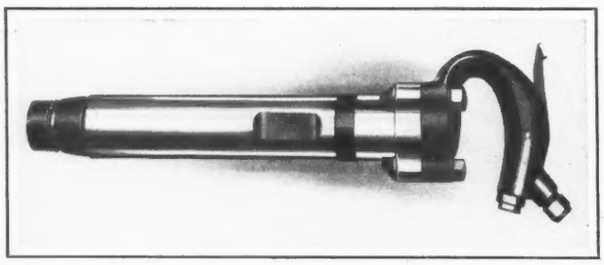
Boring, Drilling and MILLING MACHINE

WE ALSO MAKE THE
LUCAS POWER
Forcing Press

is not only kept up, but improved whenever possible.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS:—Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.



Ingersoll-Rand Pneumatic Riveting Hammer

INGERSOLL-RAND RIVETING HAMMER

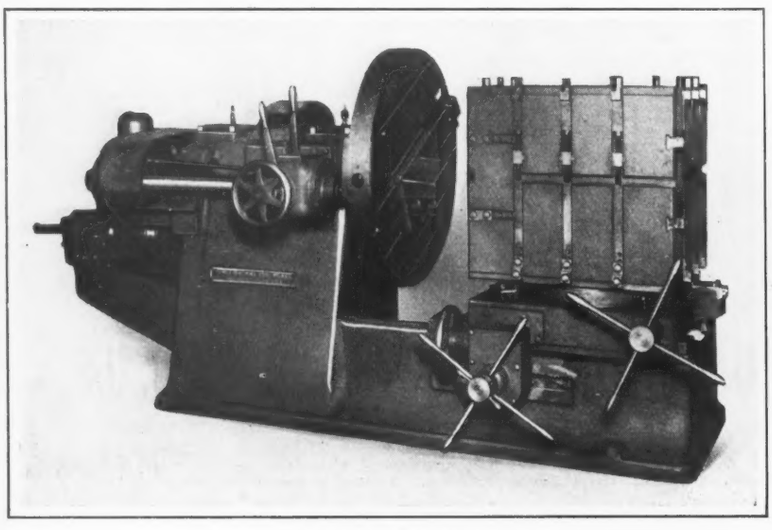
A pneumatic riveting hammer with several improved features has recently been developed by the Ingersoll-Rand Co., 11 Broadway, New York City. This riveter has a bolted construction for holding the handle to the barrel, a heavy section valve with liberal bearing surfaces, and a combination poppet and piston type throttle valve. Power in excess of ordinary requirements, low air consumption, and easy operation are among the advantages that are claimed for this hammer.

This tool is made in three styles, and is available in a range of sizes with strokes of from 5 to 9 inches. Each size of riveter can be furnished with any one of three types of barrels and with either outside or inside trigger handles. The standard A type has a barrel machined to accommodate only a rivet set clip. The handle is held to the barrel by means of three alloy steel bolts fitted with lock-washers. This construction enables the units to be readily taken apart for inspection or cleaning by the aid of only a wrench. The control from a light tap to a heavy blow is sensitive and entirely at the will of the operator.

JONES FACING MACHINE

A machine designed to perform facing operations, which has several novel features of construction, has recently been brought out by the Jones Machine Tool Works, Inc., Philadelphia, Pa. Contrary to usual practice, there is a tool-slide mounted on the faceplate, and this tool-slide may be fed either from the center of the faceplate toward the periphery or vice versa. The work is held on a large square turret block to which it may be directly bolted or held in fixtures for rapid production.

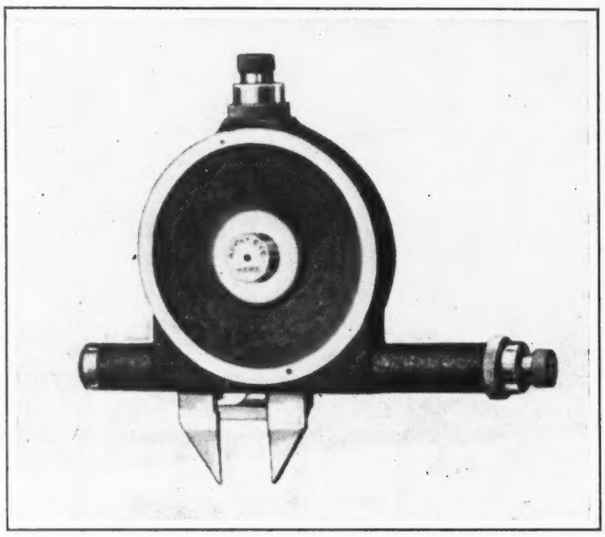
The machine is driven by a 10-horsepower constant-speed motor, which transmits power through an oil-gear arrangement, giving a uniform cutting speed at all times. For instance, when the faceplate is put in motion with the cutter starting at the periphery, the speed of the faceplate increases constantly as the cutter approaches the center of the work, and thus provides a uniform cutting speed from the start to the finish. The machine spindle may be run at any number of revolutions per minute up to 400 or more, depending on the kind of metal being machined.



Jones Facing Machine

OPTICAL GEAR-TOOTH MICROMETER

An optical gear-tooth micrometer that may be quickly and accurately set to the chordal thickness and addendum of teeth from 18 to 1½ diametral pitch, is being placed on the market by George Scherr, 126 A Liberty St., New York City. The settings can be made to within 0.001 inch by scales, and may be easily estimated to within 0.0001 inch. In setting, the instrument is held close to the eye, and by looking through the small aperture in the center, two well-defined, clear scales engraved on glass are seen. One of the scales runs vertically and the other horizontally through the center of the field. The scales are moved by turning the micrometer screws until the two measurements required—that is, the thickness of the tooth at the pitch line and the addendum—are indicated. The measuring jaws of the micrometer are then set ready for use. The tool may also be used for checking gear-cutters, gages, and forming tools used for producing the latter. The weight of this micrometer is about 1 pound.



Optical Micrometer for checking the Chordal Thickness and Addendum of Gear Teeth

* * *

DETROIT TOOL MANUFACTURERS' ASSOCIATION

An association known as the Detroit Tool Manufacturers' Association has been organized, starting with a membership of about thirty of the large tool manufacturers of Detroit, most of whom are engaged in the manufacture of tools, dies, jigs, and fixtures for the automotive industry. The first meeting of the association was held at the Detroit Athletic Club on December 11. Don F. Kennedy, president and general manager of the Sterling Mfg. Co., was elected president. The other officers are as follows: Vice-president, E. P. Kramer of F. Joseph Lamb Co.; secretary, N. A. Woodworth, of the Ex-Cell-O Tool & Mfg. Co.; treasurer, O. H. Siewek of Siewek & Snyder Tool Co. The officers and W. D. McKenzie of the Trio Tool Co. constitute the board of directors.

Wetmore Expanding 4-Blade Standard Roughing Reamer. Especially good for reaming holes preparatory to using finishing reamer, and for reaming cored holes in rough castings.

More Holes *per* Reamer!

—how *Wetmore Reamers* Cut Production Costs

FASTER work—more accurate work—and longer reamer life! That's what you get when you specify *Wetmore Expanding Reamers.*

Wetmore superiorities—many of them exclusive—are not mere claims. They can be proved—have been proved right out on the job, in competition with other reamers. You, too, can make tests—on your own work. See for yourself that *Wetmores* will do finer work, and save you money at the same time.

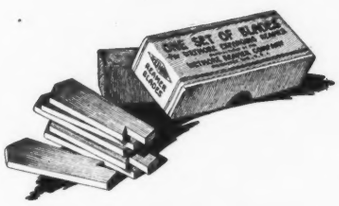
Here are just four *Wetmore* advantages—study them! You know how much they mean to you.

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made. Cone expansion nut keeps blades always parallel with axis.

Solid heat-treated alloy steel body guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering and scoring while backing out. Shearing effect of blades increases life of cutting edge.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.



Blades for All Wetmore Reamers

Scientifically ground for working various metals—steel, cast iron, bronze, etc. Best high-speed steel, ground to thickness, length and on seat. Tested for hardness and toughness. In ordering, give type and size of reamer and whether reamer is to be used on steel, cast iron or bronze.

FREE CATALOG

Write today for Wetmore catalog, showing complete line of standard, heavy-duty, shell, small machine and cylinder reamers. Also arbors and replacement blades. Sent *free—postpaid.*

Wetmore Expanding 6-Blade Standard Finishing Reamer. Assures extreme accuracy and perfect finish. Compare it with others—then judge for yourself. We'll rest our case with you.

Wetmore Reamer Co.
Milwaukee Wisconsin

WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

PERSONALS

E. M. HERR, president of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., was elected president of the Electrical Manufacturers' Club at a recent meeting in Hot Springs, Va.

JOHN CETRULE has been appointed by the Oesterlein Machine Co., Cincinnati, Ohio, district sales engineer for the New York territory, with headquarters at 50 Church St.

N. P. FARRAR has been appointed district manager of the Pawling & Harnischfeger Co., Milwaukee, Wis., manufacturer of machine tools, excavators, and cranes. Mr. Farrar's offices will be located at 605 Stephen-Girard Bldg., Philadelphia, Pa., and 50 Church St., New York City.

L. R. BROWN has been appointed manager of the transformer division of the new central station department of the General Electric Co., Schenectady, N. Y. Mr. Brown was one of the company's first transformer specialists, and has a wide acquaintance in the central station industry.

W. J. GRIMM has recently joined the selling force of the Davis Boring Tool Co., Inc., 3718 Forest Park Blvd., St. Louis, Mo. Mr. Grimm will sell the Davis line of expansion boring tools and reamers in the Philadelphia territory and throughout the greater part of Pennsylvania. His office is located in the Bourse Bldg., Philadelphia.

B. C. MASON, formerly of the Studebaker Corporation, has become a member of the sales force of the Davis Boring Tool Co., Inc., 3718 Forest Park Bldg., St. Louis, Mo., and will devote his time to the sale of Davis expansion boring tools and reamers throughout the entire state of Michigan, and principally in the Detroit district. His headquarters will be at 424 Book Bldg., Detroit.

ALVAN T. SIMONDS, president of the Simonds Saw & Steel Co., Fitchburg, Mass., has offered nine prizes to students in schools below the college grade for essays on the subject "Sharing our National Income." The first prize is $500; second, $300, and there are seven other prizes of $100 each. The contestants must be regularly enrolled pupils in public high schools, trade schools, normal schools, or private schools of similar grade. Complete conditions may be obtained from the Simonds Saw & Steel Co., Fitchburg, Mass.

A. L. JENKINS, professor of mechanical engineering, University of Cincinnati, has been commissioned Major in the Ordnance Department of the Officers' Reserve Corps of the United States Army. Major Jenkins has been on the faculty of the College of Engineering and Commerce of the University of Cincinnati since 1905. In addition to his regular duties as professor of mechanical engineering, he has charge of the technical curricula of the ordnance students who are studying for commissions in the Officers' Reserve Corps. During the war, Major Jenkins was actively engaged in training soldiers and has been engaged in military education ever since.

OBITUARY

RALPH E. GILMAN, special engineer in charge of the turbo-generator engineering of the Westinghouse Electric & Mfg. Co., died in the Methodist Hospital, Los Angeles, Cal., on December 5. Mr. Gilman had been granted a leave of absence from his duties on account of illness, so that he could go to the Coast in an effort to improve his health. He was a graduate of the Leland-Stanford University, receiving the degree of E.E. in 1898. Immediately after his graduation he entered the employ of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa., and completed the apprenticeship course of that company in January 1901. During the next two years he was located in the engineering department. In 1903 he was transferred to the British Westinghouse Co. and spent the next five years in London. He was recalled to East Pittsburg in 1908 and assigned to special duties in the power engineering departments, where he was employed until the time of his death.

In an article in the *Transactions* of the Faraday Society, it is mentioned that Dr. Onnes succeeded, in recent experiments with liquid helium, in obtaining a temperature of only 0.9 degree above the absolute zero. Even at this low temperature, helium did not solidify, and Dr. Onnes expresses the opinion that it is possible that this element does not solidify even if the temperature could be brought down to the absolute zero. The latest scientific researches indicate that the location of the absolute zero on the regular Centigrade scale is at —273.13 degrees.

TRADE NOTES

PITTSBURG GEAR & MACHINE CO., 27th and Smallman Sts., Pittsburg, Pa., has been appointed distributor in the Pittsburg district for the roller chain and silent chain made by the Whitney Mfg. Co. of Hartford, Conn.

WESTINGHOUSE ELECTRIC INTERNATIONAL CO., 165 Broadway, New York City, has combined with some Japanese electrical interests to form a Japanese electrical manufacturing company which will be known as the Mitsubishi Electric Mfg. Co.

J. L. OSGOOD TOOL CO., 43-45 Pearl St., Buffalo, N. Y., has just put into effect a price reduction of approximately 55 per cent on its line of pliable rubber safety file grips for the front end of files known as Osgood's "Filegrip." The decrease in price is due to increased sales, improved methods of production, and a reduction in the price of rubber.

DAVIS MACHINE TOOL CO., INC., Rochester, N. Y., has disposed of that part of its business relating to keyseating machines to the DAVIS KEYSEATER CO., 255 Mill St., Rochester. The new company will specialize in keyseating machines, and will carry in stock a sufficient supply of parts and cutters so that the requirements of former customers can be supplied promptly.

PHOENIX DIE CASTING CO., Buffalo, N. Y., is increasing its casting room capacity over 20 per cent by taking over a large additional section of the brick building at 21 Illinois St., which it has occupied for several years. The main office will be moved to the third floor, and will be enlarged to include an engineering and drafting department. It will also contain the office of the shop executive.

J. E. RHOADS & SONS, 35 N. 6th St., Philadelphia, Pa., manufacturers of leather belting, have opened a store in Atlanta, Ga., at 68 S. Forsyth St., where they will carry Tanna flat and round belting, Tanna lace leather, and belt accessories. The company has recently moved into a new building in Philadelphia, their store and offices being located on the first floor. They also have stores in New York and Chicago.

DIAMOND CHAIN & MFG. CO., Indianapolis, Ind., manufacturer of steel roller and block chains for the transmission of power, has completed arrangements with the Chain Belt Co. of Milwaukee to act as its representative on the Pacific Coast through the Chain Belt Co.'s newly established branches at 1040 Sixth Ave., S., Seattle, Wash., and 67-69 First St., Portland, Ore. A complete stock of Diamond chains will be carried in these offices.

OAKLEY CHEMICAL CO., 26 Thames St., New York City, held its seventh annual sales conference at the general office of the company, December 3 to 5, when about 75 of the company's sales representatives were present. During this conference the uses of Oakite in various industries were brought out, including the application in machine shops, power plants, textile plants, railroad shops, and garages. A number of social features also characterized the conference.

GENERAL ELECTRIC CO., Schenectady, N. Y., has purchased five acres of land in Los Angeles, Cal., on the southwest corner of Santa Fe Ave. and 52nd St., and will immediately modify and convert the two-story reinforced concrete building at present standing on the property into a fully equipped service shop in which all kinds of electrical apparatus will be rebuilt and repaired. Later a large warehouse will be built on the property, and eventually a factory will be erected there.

* * *

CENSUS OF MANUFACTURES

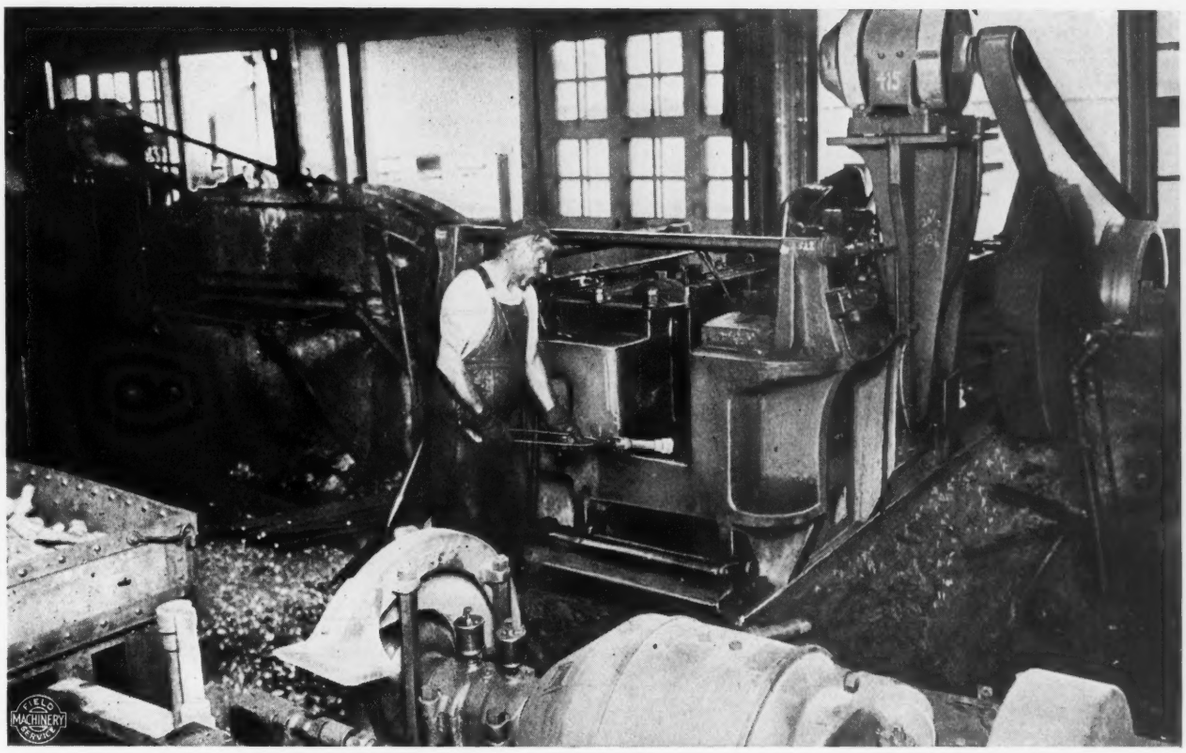
The Bureau of the Census is now engaged in collecting statistics of manufactures covering the year 1923. The schedules have been prepared after conference with the associations and others interested in the various industries. Schedules to be filled out will be mailed on January 2, and manufacturers of machine tools and metal-working machinery are urgently requested to forward their reports to the bureau early in January. The bureau has agreed to tabulate the results as rapidly as the schedules are received and publish the details within a few days after the receipt of the last report. Manufacturers should show their appreciation of the service that the bureau renders to the industry by returning the schedules as promptly as possible.

* * *

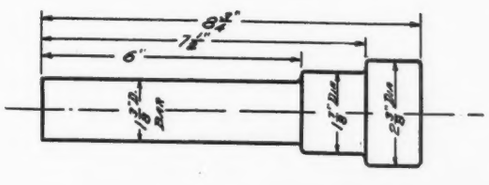
The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has issued its 1923 Book of Tentative Standards. This book, of 859 pages, contains all the 190 tentative standards of the society.

AJAX

(Trade Mark Registered)



Forging Equipment that "Carries Through" —*Profitably*



Let us send the Bulletin.

Ajax is well represented in this big automobile manufacturing plant by nine Forging Machines as well as Hot Saws and other auxiliary forging equipment.

And, as always, there are reasons: production of 1000 per 8-hour day of these 3½% nickel steel transmission clutch shafts is one.

Bars 1⅜" diameter, 13½" long are heated in an oil furnace formed in one operation in the Ajax Upsetter and then trimmed to length in an Ajax Hot Saw. A crew of 2 handles the entire sequence and this production is easily maintained.

Dependability, high production and low operating costs are three good reasons for a machine's popularity. Ajax Forging equipment wins on all three counts.

THE AJAX MANUFACTURING CO.
CLEVELAND, OHIO

621 Marquette Bldg.
CHICAGO, ILL.

1369 Hudson Terminal
NEW YORK CITY

COMING EVENTS

January 18—Annual meeting of the American Society of Safety Engineers in New York City.

January 22-25—Annual meeting of the Society of Automotive Engineers in the General Motors Building, Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

January 31-February 1—Winter sectional meeting of the American Society for Steel Treating in Rochester, N. Y. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

April 28-30—Annual meeting of the American Gear Manufacturers' Association at Buffalo, N. Y. Secretary, T. W. Owen, Room 107, 2443 Prospect Ave., Cleveland, Ohio.

April 30-May 2—Eleventh convention of the Society of Industrial Engineers in Buffalo, N. Y. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

May 19-21—Joint convention of the Southern Supply and Machinery Dealers' Association, the National Supply and Machinery Dealers' Association, and the American Supply and Machinery Manufacturers' Association, in Cleveland, Ohio; headquarters, Hotel Cleveland. Secretary-treasurer, F. D. Mitchell, 1819 Broadway, New York City.

May 19-22—Spring meeting of the American Society of Mechanical Engineers at Cleveland, Ohio. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

June 4-6—Eleventh annual foreign trade convention in Boston, Mass. O. K. Davis, India House, Hanover Square, New York City, secretary.

June 11-18—Convention and exhibit of Section V Mechanical, of the American Railway Association in Atlantic City, N. J.

June 11-18—Convention and exhibit of the Railway Supply Manufacturers' Association in Atlantic City, N. J. Secretary, J. D. Conway, 1841 Oliver Bldg., Pittsburg, Pa.

NEW BOOKS AND PAMPHLETS

Steaming Horizontal Stop-end Coal Gas Retorts. By George W. Burke and C. J. Myers. 20 pages, 6 by 8½ inches. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 66 of the Engineering Experiment Station.

The Strength of Concrete—its Relation to the Cement Aggregates and Water. By Arthur N. Talbot and Frank E. Richart. 118 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 137 of the Engineering Experiment Station. Price, 60 cents.

Test Code for Hydraulic Power Plants and their Equipment. 22 pages, 7¾ by 10½ inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, 80 cents (to members 70 cents) and in quantities of 25 or more, 65 cents.

This is the first of a series of sixteen test codes which are to be issued during the coming year by the Power Test Code Committee of the American Society of Mechanical Engineers as a result of its years of work on the revision of the test code of 1915.

NEW CATALOGUES AND CIRCULARS

Stromberg Electric Co., 223 W. Erie St., Chicago, Ill. Pamphlet descriptive of the new Stromberg fully automatic in-and-out time recorder.

Gwilliam Co., 23 Flatbush Ave., Brooklyn, N. Y. Post card illustrating the line of light- and heavy-duty ball and roller bearings made by this company.

J. L. Osgood Tool Co., 43-45 Pearl St., Buffalo, N. Y. Pamphlet containing revised list prices for the line of pliable rubber safety file grips made by this concern.

Wagner Electric Corporation, St. Louis, Mo. Circular advertising Wagner transformers, which are built for all standard requirements of either distribution or power service.

Air Reduction Sales Co., 342 Madison Ave., New York City. Pamphlet entitled "Care of Oxygen and Acetylene Cylinders," containing full directions for the care and use of this equipment.

D'Olier Centrifugal Pump & Machine Co., 165 Broadway, New York City. Bulletin 126-3, descriptive of some large centrifugal pumps which have been made by this company to meet special requirements.

George Sachsenmaier Co., 926 N. Third St., Philadelphia, Pa. Leaflet containing a brief description, together with specifications, of the Dunning electric-driven air compressors and automatic tank units.

Baird Machine Co., Bridgeport, Conn. Circular entitled "Can the Prospect Pay Your Cost?", containing descriptions of the tandem press, four-slide automatic, and steam drying out barrel made by this concern.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Calendar for 1924, 16 by 24 inches in size, containing on each sheet the calendar for three months, and illustrations showing the construction features of the various types of Link-Belt chain.

New Departure Mfg. Co., Bristol, Conn. Sheets Nos. 158-FE and 159-FE for loose-leaf binder, illustrating applications of New Departure double-row and single-row ball bearings in low-duty centrifugal pumps and speed reduction gears, respectively.

Philip Carey Co., Lockland, Cincinnati, Ohio. Bulletin 101, on high-temperature heat insulation, discussing the performance and adaptability of heat-insulating materials, with particular reference to the "Hi-temp" pipe covering made by this concern.

Bausch & Lomb Optical Co., Rochester, N. Y. Catalogue of Bausch & Lomb binocular microscopes of the Greenough type, an instrument which enables the user to view the image in its true position, not inverted or reversed as in the monocular type.

Wiesman Mfg. Co., Fourth and St. Clair Sts., Dayton, Ohio. Circular outlining the features of the new and improved Wiesman safety guard for presses, which automatically prevents the operator from putting his hand between the dies while the press is in operation.

Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Catalogue 14, of Hanna air hoists, containing illustrations of the different styles, detailed description, dimension data, and other specifications. These hoists are designed either for portable use or for use in a fixed position.

Chicago Belting Co., 127 N. Green St., Chicago, Ill. Circular describing "Reliance" belt cement and "Sea Lion" belt cement. The "Reliance" cement is intended for all places where a non-waterproof cement is required, and the "Sea Lion" cement for places where a waterproof cement is needed.

Union Switch & Signal Co., Swissvale, Pa., manufacturer of drop-forgings, has issued a calendar for 1924, showing three months on each page, the current month being printed on a black background to distinguish it from the previous and following months, which are printed on an orange background.

U. S. Galvanizing & Plating Equipment Corporation, 32 Stockton St., Brooklyn, N. Y. Circular illustrating U. S. moving-cathode plating apparatus for plating with nickel, brass, copper, tin, silver, gold, and zinc. Some of the many classes of products for which this process is applicable are shown.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Twenty-four page booklet entitled "A Material of Endless Possibilities," containing information about "Micarta" and the many uses to which it has been put, including bushings, fan blades, gears, gaskets, handles, knobs, pinions, pulleys, telephone apparatus, washers, etc.

Henry Prentiss & Co., Inc., 149 Broadway, New York City. Circular illustrating the Boston universal angle-plate made by the Boston Scale & Machine Co.—a precision tool for holding work at any desired angle. The pamphlet contains illustrations showing the angle-plate in various positions for doing different classes of work.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 106-A, descriptive of the new Hisey 5/16-inch capacity side-handle electric drill, which is made in two types, one of which is a high-speed machine adapted for both wood and metal drilling, and the other a machine intended for drilling very hard metals, where a slow speed is preferred.

W. A. Jones Foundry & Machine Co., 4409 W. Roosevelt Road, Chicago, Ill. Catalogue 20-A, containing illustrations and tables of specifications covering the Jones line of power transmitting machinery, including drop hangers, belt-shifting attachments, pillow blocks, thrust boxes, compression couplings, baseplates, cold-rolled steel shafting, etc.

Shaw Blueprinting Machine Co., Inc., formerly at 5 Campbell St., Newark, N. J., has moved its store, manufacturing plant, and paper coating department to its own building at 15 Mechanic St., Newark. The company will continue to manufacture its old line of blueprinting machinery and will also bring out a new line of blueprinting machines.

Moline Tool Co., Moline, Ill. Catalogue illustrating and describing the "Hole Hog" line of multiple drilling machines made by this company. Full-size halftone illustrations and detailed line illustrations of the different sizes and styles of machines are included, as well as brief descriptions covering the salient features of construction, capacity, dimensions, etc.

Simonds Saw & Steel Co., Fitchburg, Mass., has issued a booklet entitled "Selling Engineers vs. Salesmen," primarily for the purpose of educating its salesmen and supply dealers who sell Simonds saws and machine knives, in a wider knowledge of the technical side of their work. The book illustrates and describes the manufacture of Simonds steel and its application in various lines of goods.

Pratt & Whitney Co., 111 Broadway, New York City. Catalogue 11, covering the complete line of small tools and gages made by this concern. This edition contains the latest data on taps, dies, screw plates, milling cutters, reamers, punches, drills, tool-holders, hollow mills, counterbores, gages, micrometers, and miscellaneous tools. Tables of specifications, including sizes and prices, are given for all the different classes of tools.

Cleveland Automatic Machine Co., Cleveland, Ohio. Production bulletin—treatise No. 4, illustrating typical jobs handled on Cleveland automatics. The bulletin gives production figures and other pertinent data for each job. Among the pieces included as examples are automobile hubs, globe, valve spindles, studs and screws for oil-well machinery, cast-iron bolster cases for textile machinery, bicycle hubs and other bicycle parts.

Colonial Supply Co., 217 Water St., Pittsburg, Pa. Pamphlet entitled "The Kite's Tail," illustrating and describing transmission equipment which this company handles, including S K F ball-bearing drop hangers, adapter bearings, loose pulleys, and friction clutch pulleys, Master friction clutches, Hess-Bright deep-groove ball bearings, Barry steel split pulleys, Alexander leather belting, Detroit belt-lacers, Bond anti-friction truck casters, and Hallowell lift-truck platforms and steel bench legs.

Linde Air Products Co., 30 E. 42nd St., New York City, is issuing a book on the subject of cast-iron welding by the oxy-acetylene process, which contains considerable general information on the welding of cast iron, including the equipment required, preparation of work, preheating, welding, annealing, finishing, testing welds, and estimating weld costs. Some typical cast-iron welding jobs are illustrated and described, and an appendix is included which contains practical problems in cast-iron welding.

Smith & Serrell, Central Ave. at Halsey St., Newark, N. J. Bulletin 37, covering the Francke line of flexible couplings for direct-connected machines. On pages 20 and 21 is shown the new high-speed type Francke flexible coupling for geared turbine and for high-speed motor drives, and on page 24, the new pressed-steel type coupling for small auxiliary drives. The pamphlet also contains information relating to lubrication and the installation and operation of direct-connected machines. Many typical direct-connected power installations are illustrated.

Marquette Tool & Mfg. Co., 319 W. Ohio St., Chicago, Ill. Catalogue 3, of Marquette pneumatic die cushions, which are made in a wide variety of styles applicable to both large and small presses, of either the single-acting or double-acting type. Halftone and line illustrations of the different types of cushions are shown, and table giving the essential dimensions are included. The book also contains illustrations showing installations of Marquette pneumatic cushions on different styles of presses. Copies will be sent, upon request, to those interested in sheet-metal drawing.

Toledo Machine & Tool Co., Dorr St. and New York Central Railroad, Toledo, Ohio. Reference book on Toledo presses, containing illustrations, general descriptions, and tables of complete specifications for the various types of presses made by this company. The book also contains useful tables, such as areas and circumferences of circles, approximate diameter of blanks for shells, decimal equivalents, sheet metal and wire gages, weights of round and square steel, weights of sheet-steel blanks, and much other data of general interest. It is published in vest-pocket size for convenient reference.

Firth-Sterling Steel Co., 310 Hudson St., New York City, has published a book treating of the subject of stainless steel, which covers comprehensively the corrosion-resisting properties, physical characteristics, practical manipulation, and field of application of stainless steel. The book has been prepared with the object of bringing before those interested in stainless steel such data as may save the trouble and expense of conducting experiments in the fields where experience has shown that it has or has not been found suitable. The information is based on experiments made in the company's laboratories, as well as upon reports from customers who are using the material. It is bound in cloth, and should be found a useful handbook on this subject.

William Ganschow Co., 1001 W. Washington Blvd., Chicago, Ill., has published a new handbook on gears and speed transformers, which is combined with the company's general catalogue No. 100. The purpose of the handbook is to afford the users of these products easy access to formulas and data regarding their design and use. It also contains information of use in the designing of machinery to which gears and speed transformers may be applied, as well as tables giving the strength and weight of materials, trigonometric functions, geometric formulas, decimal equivalents, wire and sheet-metal gages, and standard screw threads. The catalogue section gives complete lists of all products regularly manufactured by this company. Copies of the book will be sent to manufacturing executives upon request.